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Homeland Security**

**United States
Coast Guard**



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APR 19 2010

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Dear Mr. Thompson:

Attached for your files as enclosure (1) is the final Removal Action Completion Report for the investigation at the U.S. Coast Guard Old Station Ludington located in Mason County, Ludington, Michigan.

If you have any comments to this document, please contact Mr. Greg Carpenter at 216-902-6219.

Sincerely,

A handwritten signature in black ink, appearing to read "Frank A. Blaha".

Frank A. Blaha
Chief, Environmental Compliance
By direction of the Commanding Officer

Enclosures: (1) U.S. Coast Guard Removal Action Completion Report Old Station Ludington,
Ludington, Michigan, January 2010.

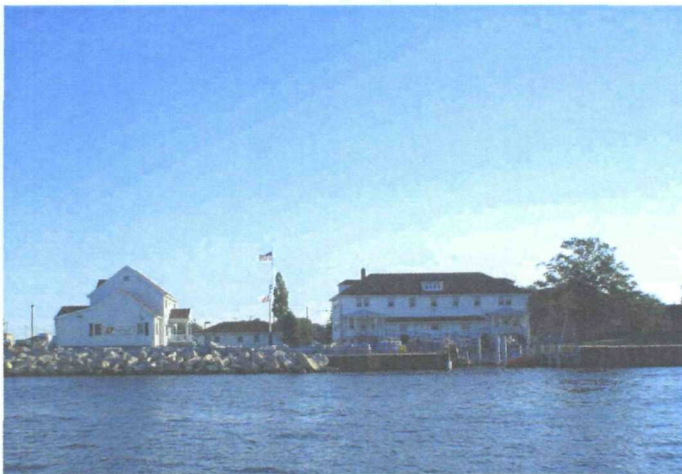


U.S. Coast Guard

Removal Action Completion Report

**Old Station Ludington
Ludington, Michigan**

January 13, 2010



Imagine the result

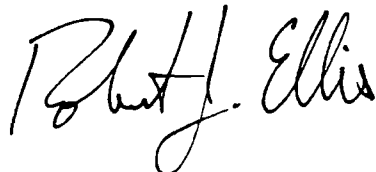
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**Removal Action Completion
Report**

Old Station Ludington
Ludington, Michigan

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Executive Summary

As provided in Executive Order 12580 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the U.S. Coast Guard (USCG) is acting as the lead agency in implementing a Non-Time-Critical Removal Action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at the Old Station Ludington (Site) located in Ludington, Michigan. The removal action was conducted, and this Removal Action Completion Report was prepared, utilizing other supporting documents, including the Engineering Evaluation/Cost Analysis, the project-specific Quality Assurance Project Plan, the Quality Assurance Project Plan Addendum, and the Removal Action Work Plan.

The removal action was conducted in accordance with the United States Environmental Protection Agency (USEPA) *Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA* (1993) to address soil impacted by lead above Site-specific removal action objectives (RAOs) associated with the historical application and weathering of lead-based paint on the building exterior. The primary objective of the removal action was to protect public health and welfare and the environment, thereby facilitating the transfer of the Site from the federal inventory to the City of Ludington. The anticipated future use of the Site is recreational (e.g., park or museum). The USCG selected a Site-specific RAO for lead in soil of 400 milligrams per kilogram (mg/kg). The RAO of 400 mg/kg is based on the recommended screening levels for lead in soil for residential land use provided in the *Revised Interim Soil Lead Guidance for CERCLA Sites and Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities* and the Michigan Department of Environmental Quality (MDEQ) soil Direct Contact criterion for residential land use (Part 201 of the Michigan Natural Resources and Environmental Protection Act (NREPA), Public Act 451, as amended, [Part 201]).

Between 2001 and 2008, site assessments, investigations, and a Cultural Resources Survey were conducted at the Site. According to the Commonwealth Cultural Resources Group, Inc. *Phase I Cultural Resource Assessment, Ludington Life Saving Station, Mason County, Michigan*, the first Life Saving Station was constructed in 1873 and replaced by the current Old Station Building in 1934. According to the URS Group, Inc. *Final Phase I Environmental Site Assessment (ESA), USCG Station Ludington, Michigan*, the Old Station Building included offices, a galley, a mess deck, and berthing rooms. According to USCG personnel, the USCG put up vinyl siding on the Old Station Building in 1985. Following the construction of the new Station Building in 2004, the Old Station Building has been used for storage of miscellaneous equipment.

The City of Ludington contracted Otwell Mawby, P.C. to prepare a Phase I ESA at the Site in 2007 in support of their due diligence prior to transfer of the Site from the federal government, which is expected to occur upon completion of the removal site evaluation and soil removal action. The Phase I ESA indicated that a former 300-gallon waste oil underground storage tank (UST) adjacent to the Old Station Building was removed from the Site. Two floor drains were also identified on the lower level of the Old Station Building. A lead-paint survey was recommended due to the age of the building.

A Phase II ESA was conducted in July 2008 by Otwell Mawby and included a soil and groundwater investigation to further evaluate the UST area and floor drains. Results of this investigation indicated that soil or groundwater samples collected for analyses of volatile organic compounds, semi-volatile organic compounds, and the Michigan 10 metals did not contain concentrations of these constituents above generic Michigan Department of Environmental Quality (MDEQ) cleanup criteria or statewide default background levels at the Site.

The USCG contracted a geophysical survey of the Site in August 2008 to identify any potential remaining USTs or UST components. The results of that survey indicated no evidence of buried USTs or residual piping or UST system components, which is consistent with the information in the Phase I ESA included in the EE/CA for Old Station Ludington.

In August 2008, the USCG performed Site characterization sampling in accordance with the Site-specific Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP) to determine if impacts to soil and groundwater were present at the Site related to historical use of lead-based exterior building paint. Soil lead impacts were identified as a result of historical application and subsequent weathering of lead-based paint on the exterior of the Old Station Building. No other sources of contamination have been identified at the Site.

An EE/CA and a RAWP were prepared to summarize results of the Site characterization and the plan for removal action. The EE/CA and RAWP were made available for public comment between May 1, 2009 and June 12, 2009, and the documents were provided to the MDEQ for review and comment. No comments were received from the public. The MDEQ provided a letter indicating the RAWP was acceptable and appropriate and complies with the State of Michigan regulations. Prior to implementing the soil removal, a QAPP Addendum was prepared to document a change in laboratory method for lead analysis from Flame Atomic Absorption (USEPA

Method 7420) to Inductively Coupled Plasma (ICP) (USEPA Method 6010) for soil and ICP-Mass Spectrometry (USEPA Method 6020A) for groundwater.

Soil removal activities took place July 20 through 24, 2009. Near-surface soils were removed to depths ranging from 12 inches to 24 inches below ground surface (bgs). Soil samples were collected from the excavation bottoms and sidewalls for field screening using a portable x-ray fluorescence (XRF) analyzer as described in the RAWP. If lead concentrations greater than 300 mg/kg were observed during field screening, additional soil was removed in that area and another sample was collected for field screening. If XRF analyzer readings indicated lead concentrations less than 300 mg/kg, then soil removal activities ceased in that area, and a confirmation sample was collected for laboratory analysis.

Approximately 39.4 tons of nonhazardous lead-impacted soil were excavated and transported to the Allied Waste Landfill in Manistee, Michigan for disposal. Restoration activities took place August 4 and 5, 2009. The excavations were backfilled with sand and topsoil and either seeded with grass seed and covered with straw mat or covered with landscaping fabric and decorative rock to restore the areas to pre-excavation condition. Laboratory analytical results for the removal confirmation samples were all below the RAO of 400 mg/kg. Soil impacted with lead concentrations above the RAO of 400 mg/kg has been removed from the Site. Therefore, additional removal action is not warranted.

Groundwater samples were collected on a quarterly basis as described in the EE/CA in August 2008, November 2008, February 2009, and May 2009. Groundwater samples were submitted for laboratory analysis of total and dissolved lead in accordance with the QAPP and QAPP Addendum. All groundwater analytical results were below the groundwater screening level of 4 micrograms per liter ($\mu\text{g/L}$) presented in the EE/CA. No evidence of soil impacts affecting groundwater has been observed at the Site. Therefore, the USCG intends to abandon the three monitoring wells upon completion of the project.

1. Introduction

This Removal Action Completion Report (RACR) was prepared by ARCADIS on behalf of the United States Coast Guard (USCG) for the eastern portion of the USCG Station Ludington, known as Old Station Ludington (Site), located in Ludington, Michigan (see Figure 1). The Site is located along the north side of the Pere Marquette River in Ludington, Michigan (see Figure 1). The portion of USCG Station Ludington to be transferred to the City of Ludington includes the Old Station Building and landscaped area to the east of the Old Station Building (see Figure 2). The Site occupies a portion of Section 16, Township 18 North (T18N), Range 18 West (R18W), in the city of Ludington, in Mason County, Michigan. The federal government currently owns the Site, which encompasses approximately 0.38 acres of land.

The active Station Ludington is located on the adjacent property to the west of the Site and includes the new Station Building, a shop/engineering building, and a boat slip along the Pere Marquette River.

The removal action completed for the Site included the excavation and disposal of lead-impacted near-surface soils associated with historical use of lead-based paint on the exterior of the Old Station Building. The removal action was conducted in accordance with the United States Environmental Protection Agency (USEPA) *Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA* (Comprehensive Environmental Response, Compensation and Liability Act; 1993). The primary objective of the removal action was to protect public health and welfare and the environment, thereby facilitating the transfer of the Site from the federal inventory to the City of Ludington. The anticipated future use of the Site is recreational (e.g., park or museum). The USCG selected a Site-specific removal action objective (RAO) for lead in soil of 400 milligrams per kilogram (mg/kg). The RAO of 400 mg/kg is based on the recommended screening levels for lead in soil for residential land use provided in the *Revised Interim Soil Lead Guidance for CERCLA Sites and Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities* (United States Environmental Protection Agency 1994) and the Michigan Department of Environmental Quality (MDEQ) soil Direct Contact criterion for residential land use (Part 201 of the Michigan Natural Resources and Environmental Protection Act (NREPA), Public Act 451, as amended, [Part 201]).

1.1 Background

The first Life Saving Station was constructed in 1873 and replaced by the current Old Station Building in 1934 (Commonwealth Cultural Resources Group Inc. 2008). The Old Station Building included offices, a galley, a mess deck, and berthing rooms. The Engineering Building (Shop) was built to the west of the Site between 1972 and 1981. According to USCG personnel, the USCG put up vinyl siding on the Old Station Building in 1985. Following the construction of the new Station Building in 2004, the Old Station Building has been used for storage of miscellaneous equipment (URS Group Inc. 2001). The Station's primary responsibility is to provide search and rescue operations, covering an operational area of approximately 35 nautical miles of coastline encompassing 1,050 square miles (United States Coast Guard 2008).

A Phase I environmental site assessment (ESA) was conducted by URS Group Inc. (URS) on the Site and on the parcel of land to the west of the Site that is also owned by the USCG. The results are presented in the Final Phase I Environmental Site Assessment dated February 20, 2001 (URS Group Inc. 2001). The report identified two possible USTs on the land to the west of the Site owned by USCG based on historical documentation.

A second Phase I ESA focusing on the portion of the property to be transferred to the City of Ludington was prepared by Otwell Mawby, P.C. for the City of Ludington. Results of the Phase I are presented in the *Phase I Environmental Site Assessment* dated April 30, 2007 (Otwell Mawby, P.C. 2007). The Phase I identified a former waste oil underground storage tank (UST) adjacent to the Old Station Building to the west, as well as the possibility of impacts related to a floor drain where boats had been kept inside the Old Station Building and the potential for asbestos and lead-based paint based on the age of the buildings. A copy of the Phase I ESA was included in the Engineering Evaluation/Cost Analysis (EE/CA) for Old Station Ludington (ARCADIS U.S., Inc. 2009a).

A Phase II ESA was performed by Otwell Mawby for the City of Ludington in July 2008. During the Phase II ESA, soil borings and temporary monitoring wells were placed near the former waste oil UST along the west side of the Old Station Building and near the floor drains in the garage. Two soil and groundwater samples were collected near the floor drains, and one soil sample and groundwater sample were collected from the area surrounding the former waste oil UST. Results of the Phase II ESA are presented in the Phase II Environmental Site Assessment dated July 28, 2008 (Otwell Mawby, P.C. 2008). Results of the Phase II ESA indicated that soil and groundwater samples

collected for analyses of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and the Michigan 10 metals did not contain concentrations above generic MDEQ cleanup criteria or statewide default background levels at the Site. A copy of the Phase II ESA was included in the EE/CA for Old Station Ludington (ARCADIS U.S., Inc. 2009a).

A geophysical investigation was performed in August 2008 by Geosphere, Inc. The survey investigated the Site, as well as the active USCG Station west of the Site, for potential buried tanks, piping, and other potential sources of contamination. Results of the geophysical survey are presented in the EE/CA (ARCADIS U.S., Inc. 2009a). The survey located several anomalous structures in the area immediately south of the Shop (west of the Site). The anomalies were interpreted as old concrete footings for potential former aboveground tanks or gravel backfill from old excavations. No evidence of buried tanks or drums was identified on the Site or the adjacent active Station Ludington in the areas surveyed. A copy of the geophysical survey report was included in the EE/CA for Old Station Ludington (ARCADIS U.S., Inc. 2009a).

In accordance with Section 106 of the National Historic Preservation Act (NHPA), a Cultural Resources Survey was performed prior to initiating Site evaluation and removal action work at the Site. The Cultural Resources Assessment was performed in July 2008 by Commonwealth Cultural Resources Group (CCRG) and included an archeological field investigation, shovel tests, an aboveground assessment of the Old Station Building, and a historical literature and records review. CCRG concluded that the Site does not warrant recommendation for listing in the National Register of Historic Places (NRHP), nor does the Site contain any significant archaeological materials. Results of the assessment were submitted to the Michigan State Historic Preservation Officer (SHPO) on September 25, 2008. The USCG subsequently received a letter from the SHPO dated January 15, 2009 stating that the proposed removal activities would not adversely affect the Old Station Ludington and that the USCG is in compliance with Section 106 of the NHPA. Results of the Cultural Resources Survey and evaluation by the SHPO are described in detail in the EE/CA (ARCADIS U.S., Inc. 2009a).

In August 2008, soil and groundwater sampling were performed at the Site to assess potential impacts related to lead-based paint. The assessment included the collection of 115 soil samples for field screening and 68 soil samples for laboratory analysis and the installation of three monitoring wells for the collection of quarterly groundwater samples. The results of this investigation are discussed in detail in the EE/CA (ARCADIS U.S., Inc. 2009a). The results of this investigation indicated areas of near-

surface soil impacts above the RAO adjacent to the Old Station Building and in the grassy lawn area east of the building. No groundwater lead impacts were observed.

In April 2009, an EE/CA was prepared for the Site summarizing the results of investigation activities performed to date and evaluating potential alternatives for addressing the lead impacts identified in soil. The EE/CA identified applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) guidance, as required under Section 121 (d) of CERCLA, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA) and Section 300.400(g) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The USCG solicited input from the MDEQ in evaluating potential state ARARs in a letter dated September 25, 2008. A response from the MDEQ regarding ARARs was not received. Both federal and state statutes and regulations were considered in the analysis of potential ARARs. The ARARs evaluation process is described in detail in the EE/CA (ARCADIS U.S., Inc. 2009a). A summary of ARARs and TBC guidance identified for the Site is presented in Table 1.

The EE/CA identified removal of the impacted soil as the most effective, implementable, and cost-effective action for the Site, and a Removal Action Work Plan (RAWP) was prepared for the Site (ARCADIS U.S., Inc. 2009b). The RAWP described the plan for implementing removal action activities and provided standard operating procedures (SOPs) for the field activities. A Quality Assurance Project Plan (QAPP) Addendum (ARCADIS U.S., Inc. 2009c) was also prepared to document the change in laboratory analytical method for lead analysis from Flame Atomic Absorption (USEPA Method 7420) to Inductively Coupled Plasma (ICP) (USEPA Method 6010) for soil and ICP-Mass Spectrometry (USEPA Method 6020A) for groundwater. The soil removal and Site restoration activities were conducted in July and August 2009.

1.2 Chronology of Events

The following is a brief chronology of events associated with the Site activities.

- February 2001: USCG conducted Phase I Environmental Site Assessment (URS Group Inc. 2001).
- April 2007: City of Ludington conducted Phase I Environmental Site Assessment (Otwell Mawby, P.C. 2007).

- July 2008: City of Ludington conducted Phase II Environmental Site Assessment (Otwell Mawby, P.C. 2008).
- August 1, 2008: USCG Submitted draft Quality Assurance Project Plan and Field Sampling Plan to USEPA for review (ARCADIS U.S., Inc. 2008a; 2008b).
- August 8, 2008: Quality Assurance Project Plan and Field Sampling Plan finalized (ARCADIS U.S., Inc. 2008c; 2008d).
- August 2008: USCG performed additional Site characterization soil sampling, monitoring well installation and groundwater sampling activities.
- February 11, 2009: USCG Submitted draft Engineering Evaluation/Cost Analysis to USEPA for review (ARCADIS U.S., Inc. 2009d).
- March 17, 2009: USCG Submitted draft Removal Action Work Plan to USEPA for review (ARCADIS U.S., Inc. 2009e).
- April 3, 2009: Engineering Evaluation/Cost Analysis and Removal Action Work Plan finalized (ARCADIS U.S., Inc. 2009a; and 2009b, respectively).
- May 1, 2009: Engineering Evaluation/Cost Analysis and Removal Action Work Plan made available for public review and comment.
- June 2, 2009: Quality Assurance Project Plan Addendum finalized (ARCADIS U.S., Inc. 2009c).
- June 12, 2009: Public comment period ended; no public comments received by the USCG.
- July 20, 2009 through August 5, 2009: USCG performed soil removal action, removal confirmation sampling, and Site restoration activities.

1.3 Public Participation and Response to Comments

In accordance with the NCP, a Public Notice (Appendix A) was provided by the USCG announcing that the EE/CA and RAWP for the proposed removal action at the Old Station Ludington were available for public review and comment for a period of 30

days. The purpose of the public participation requirement of the NCP is to promote active communication between the communities affected by the release at the Site and the USCG. Copies of the EE/CA and RAWP were placed at Mason County District Library and the City of Ludington City Hall. An electronic copy of the documents was also posted on the City of Ludington website. A public notice of availability for review and comment was posted in the Ludington Daily News from May 1, 2009 through May 9, 2009. The EE/CA and RAWP were left available for review and comment for two additional weeks beyond the proposed 30 day comment period to allow for any late comments, and the comment period was closed June 12, 2009. A copy of the EE/CA and RAWP were also submitted to the MDEQ for review and comment.

Comments were received from the MDEQ in a letter dated May 21, 2009 (Appendix A). In that letter, the MDEQ indicated that following a review of the RAWP the plan was considered acceptable and appropriate and complied with State of Michigan regulations. The USCG received no comments from the community during the public comment period. Therefore, consistent with provisions (Title 40 Code of Federal Regulations 300.415) of the NCP, the USCG proceeded with implementing the removal action as planned.

2. Removal Action Activities

The removal action was conducted in accordance with the USEPA's *Guidance for Conducting Non-Time Critical Removal Actions under CERCLA* (1993). The primary objective of the removal action was to protect public health and welfare and the environment, thereby facilitating the transfer of the Site from the federal inventory to the City of Ludington for recreational use (e.g., park or museum). As discussed in the EE/CA and RAWP, the USCG selected an RAO of 400 mg/kg for lead in soil at the Site. Soil removal activities took place at the Site from July 20 through 24, 2009, and Site restoration was performed on August 4 and 5, 2009.

2.1 Pre-Removal Action Activities

2.1.1 Site Access

No permits or applications were necessary prior to commencing removal action activities. No access agreements were obtained because the federal government is the current owner of the Site, and removal activities were not expected to encroach on adjacent properties.

Portions of the removal action took place proximal to a City of Ludington manhole. The City of Ludington received a copy of the EE/CA and the RAWP for their files before the removal action was implemented. ARCADIS contacted Mr. Jon Kortge of the Ludington Utilities and Maintenance Department on June 24, 2009 regarding the soil removal activities near the City of Ludington manhole. Mr. Kortge said the planned activities would not be a problem for the City of Ludington.

A portion of the large excavation east of the Old Station Building did extend onto the adjacent Starboard Tack Condominium property east of the Site (see Figure 3). Representatives of the Condominium Association were notified, and the soil removal and restoration activities were discussed with the representatives of the Condominium Association and residents on-site. No additional actions were determined to be necessary.

2.1.2 Site Preparation

Prior to beginning the soil removal activities, the extent of each excavation was measured and marked with stakes and survey tape. The work zone was identified and fenced off with construction safety fencing, as well as a staging area for vehicles and equipment. Soil erosion control measures were installed, including silt fence and filter fabric in manholes according to the Soil Erosion and Sedimentation Control (SESC) Plan provided in the RAWP (ARCADIS U.S., Inc. 2009b). The staging of equipment and roll-off boxes was discussed with the removal subcontractor, and a plan for loading the roll-off boxes with the excavated soil was established. Figure 3 depicts the work zone, staging areas, equipment travel paths, and soil erosion controls.

2.1.2.1 Utility Clearance

Miss Dig was contacted by the removal subcontractor K&D Industries, Inc. of Midland, Michigan, and utilities were marked prior to arrival at the Site. Site plans obtained from the USCG were reviewed to determine the potential for utilities at the Site to be affected by the soil removal. A geophysical survey was performed in August 2008 by Geosphere. The survey investigated the Site, as well as the active USCG Station west of the Site, for potential buried tanks and piping and other utilities. No additional obstructions, piping, or utilities were identified within the proposed removal areas by the geophysical survey beyond the utilities that had already been identified.

An active communication line was identified within the excavation limits immediately adjacent to the northeastern corner of the building and marked by the utility company

(see Figure 3 [Excavation 1]). To avoid damage to the utilities or to the building, hand digging was performed in this area to locate the known utilities. Following an encounter with two unmarked plastic conduits, an emergency relocate was called into Miss Dig. Utility company representatives arrived on-site and confirmed that the lines encountered were no longer active. The unmarked conduits were also observed inside the Old Station Building and appeared to be abandoned. Additional electrical and communication lines were identified in Excavation 5 at the southwestern corner of the building. This area was excavated using shovels, and no damage to the utilities occurred. Several additional unknown communications lines were also discovered direct-buried within the grassy area just below the turf east of the building during the excavations. Neither the USCG nor utility company personnel were aware of the cables, but it was determined they were out-of-service installations. These cables were removed if needed to complete the excavation, or placed back in the excavation if they could be worked around. One of the communications lines was observed to be running through the hollow log discovered in Excavation 4. A similar hollow log was identified in Excavation 5 with several electrical cables and communications lines running through the log (refer to Section 2.2.2). These utilities were left in place at the bottom of Excavation 5. A record of the utility location procedures was maintained by ARCADIS, the oversight contractor, for the project files.

2.1.2.2 Historic Preservation

In accordance with Section 106 of the NHPA, the USCG contracted the completion of a Cultural Resources Survey for the Site and submitted the associated report and plans for the soil removal action to the SHPO. Results of the Cultural Resource Survey indicated that the proposed activities would have no effect on significant cultural or historic resources. The associated report and plans for the removal action were submitted to the SHPO for review on September 25, 2008 to determine if the planned soil removal activities could affect culturally or historically significant resources, if present at the Site.

The USCG subsequently received a letter from the SHPO dated January 15, 2009 stating that the proposed removal activities would not adversely affect the Old Station Ludington and that the USCG is in compliance with Section 106 of the NHPA. Results of the Cultural Resources Survey and evaluation by the SHPO are described in detail in the EE/CA (ARCADIS U.S., Inc. 2009a).

2.1.2.3 Endangered Species Assessment

The Site consists of the Old Station Building, a small grassy lawn area east of the building, and landscaped areas. The remainder of the Site is covered by pavement (e.g., driveways, sidewalks, and concrete pier) (see Figure 2). Due to the lack of suitable habitat at the Site, the USCG determined that removal action activities were not likely to adversely affect threatened or endangered species or habitat. Further, the soil removal action primarily included areas adjacent to the building, with minor disturbance of the lawn area east of the building. Therefore, the removal action was not considered likely to adversely affect threatened or endangered species.

2.1.2.4 Soil Erosion and Sedimentation Control

Because the Site is proximal to the Pere Marquette River, an SESC Plan was prepared in accordance with Part 91 of the Michigan NREPA. The SESC Plan and SESC measures are consistent with guidance provided in the 2005 MDEQ Water Bureau Soil Erosion and Sedimentation Control Program, Soil Erosion and Sedimentation Training Manual (2005). Soil erosion and sedimentation control measures were installed at the Site as detailed in the SESC Plan. The SESC Plan is included in Appendix A of the RAWP (ARCADIS U.S., Inc. 2009b).

Soil erosion and sedimentation control applied at the Site included installation of silt fencing along the edge of the Site/work zone to prevent erosion and transport of eroded soil and the installation of filter fabric in on-site and nearby storm drains and manholes (see Figure 3). Straw mats were also installed over the disturbed areas following restoration with topsoil and grass seed to prevent runoff of the topsoil while the grass is established.

Removal activities were completed in a way that minimized the potential for erosion and transport of soil from the removal areas to the adjacent surface-water bodies or nearby storm drains and manholes. During the soil excavation, the contractor excavated the impacted soil and placed the soil directly into the skid-steer bucket, which was then dumped into lined roll-off boxes, eliminating the need for stockpiling of impacted soils.

All SESC measures were maintained throughout the removal action in accordance with the SESC Plan. Prior to demobilizing, the SESC measures were removed in the locations where restoration of the site was complete. Silt fence was removed from the southwestern corner of the building because the area is covered with decorative rock,

and no vegetation is needed. Once the remaining areas of the Site were stabilized with grass cover, the remaining temporary SESC measures were removed on October 15, 2009.

2.1.3 Site Restriction and Security

It was anticipated that throughout the removal activities pedestrians would be present along the public sidewalk located south of the work zone along the Pere Marquette River and on the condominium property located to the east of the Site. During the soil removal activities, construction safety fencing was placed around the work zone and was successful at separating bystanders and pedestrians from the work area (see Figure 3). The construction safety fencing was removed following the Site restoration activities.

2.2 Soil Removal

Excavation and removal of the lead-impacted soil was conducted at the Old Station Ludington (see Figure 3) from July 20 through 24, 2009. The soil removal activities were performed by K&D, and oversight was provided by ARCADIS. Site photographs documenting the soil removal are included in Appendix B.

The proposed excavation consisted of five separate excavation areas shown on Figure 4. Three of the excavation areas (Excavations 1, 2, and 5) were immediately adjacent to the building - two east of the building and one south of the building. The two other excavations (Excavations 3 and 4) were located in the lawn to the east of the building.

The target removal depth was 12 inches below ground surface (bgs) for all five excavations. Over-excavation based on field-screening results was performed at two locations. The eastern half of Excavation 1 was extended to 18 inches bgs to locate and clear the communication conduits identified in this area. The northeastern portion of Excavation 1 was extended laterally approximately 6 inches beneath the sidewalk because a field-screened sidewall sample indicated concentrations of lead above the RAO. The southern portion of Excavation 4 was extended laterally to the east approximately 2 feet and vertically an additional 12 inches because field-screened sidewall and bottom samples indicated concentrations of lead above the RAO (see Figure 4). The total excavated depth in this area was 24 inches. The remaining excavations were all completed to 12 inches bgs within the proposed limits. The final excavation extents and depths are shown on Figure 4. The soil removed from the five separate excavations had a total area of approximately 655 square feet (ft²) and

weighed approximately 39.4 tons based on weight tickets received from the waste disposal contractor. The weight tickets are included in Appendix C.

The soil profile encountered during the excavation activities generally consisted of sand to sandy loam. Excavation activities adjacent to the building were conducted using hand shovels to expose and locate utilities in the areas where utilities were present or potentially present and to prevent damage to the building. A mini excavator was used in the excavation at the northeastern corner of the building following the location of the utilities and in the two excavations in the lawn to the east of the building. Hand-dug soil was shoveled directly into the skid-steer bucket. Soil dug with the mini excavator was transferred from the excavator bucket to the skid-steer bucket at the excavation location. Plastic sheeting was placed under the skid-steer to prevent spilling impacted soil onto unimpacted areas. The skid-steer then transferred the soil to the lined roll-off boxes staged on-site (see Figure 3).

Soil samples were collected in accordance with standard operating procedures (SOPs) included in Appendix D. Soil samples were collected from the excavations for field screening as described in the RAWP. Sidewall samples were collected at a depth of approximately 6 inches bgs. Bottom samples were collected from the excavation bottoms (i.e., 12 inches and 24 inches bgs). If the x-ray fluorescence (XRF) instrument readings indicated lead concentrations were less than 300 mg/kg, then soil removal activities ceased in that area, and a confirmation sample was collected for laboratory analysis. If the XRF instrument readings exceeded 300 mg/kg, additional soil was removed, and subsequent samples were collected for additional field screening. The field screening results are discussed further in Section 2.2.1.

Approximately 39.4 tons of nonhazardous lead-impacted soil was excavated from the Site and transported to the Allied Waste Landfill in Manistee, Michigan for disposal. All excavated material was stored and transported in three roll-off boxes. The first roll-off box was removed from the Site and transported to the disposal facility on August 18, 2009, the second on August 24, 2009, and the third on August 27, 2009. Details regarding the transport and disposal of the wastes are discussed in Section 2.2.3.

2.2.1 Field Screening Results

During the soil removal activities, field screening of soil samples that exceeded 300 mg/kg and were subsequently excavated ranged from 314 ± 6 mg/kg to $2,122 \pm 20$ mg/kg. Field screening results for final confirmation soil samples ranged from 10 ± 2

mg/kg to 261 ± 4 mg/kg. Excavation soil sample field screening results are presented in Table 2, and sample locations are depicted on Figure 4.

During the removal activities, the field screening results for excavation areas Excavation 2, Excavation 3, and Excavation 5 were all below 300 mg/kg, and confirmation soil samples were collected for laboratory analysis in accordance with the RAWP (ARCADIS U.S., Inc, 2009b).

On the northeastern side of Excavation 1 along the west side of the sidewalk, field screening indicated a lead concentration of 844 ± 10 mg/kg in Sample SLRC010008. A soil sample was collected on the opposite (east) side of the sidewalk, and field screening indicated a lead concentration of 137 ± 4 mg/kg in sample SLRC010009. Additional field screening Samples SLRC00010010 and SLRC00010011 were collected to define the exceedances of the RAO laterally. Field screening results of the additional samples were all below 300 mg/kg (see Figure 4). Based on the additional field screening samples, it was determined that the exceedance of the RAO at SLRC010008 was limited in extent and could likely be removed without compromising the sidewalk or leaving impacts in place. Six inches of additional soil was removed beneath the west side of the sidewalk, and field screening of Sample SLRC010012 (collected beneath sidewalk) indicated a lead concentration of 82 ± 4 mg/kg. A confirmation sample was collected for laboratory analysis from this location.

On the southeastern portion of Excavation 4 field screening of the bottom Sample SLRC040009 collected at 12 inches bgs indicated a lead concentration of 314 ± 6 mg/kg, and the southeastern sidewall Sample SLRC040003 indicated a lead concentration of $2,122 \pm 20$ mg/kg. The area was over-excavated to a total depth of 24 inches bgs, and an additional 2 feet of soil were removed to the east. A piece of metal approximately 6 inches in diameter was unearthed in this area, removed, and disposed with the impacted soil. Field screening of the subsequent bottom Sample SLRC040011 indicated a lead concentration of 24 ± 2 mg/kg, and the sidewall Sample SLRC040010 indicated a lead concentration of 50 ± 3 mg/kg. Confirmation samples were collected for laboratory analysis from these locations (see Figure 4).

The accuracy and reproducibility of the XRF field-screening results were assessed by comparison to laboratory analytical results and field XRF duplicates. The lead concentrations measured with the XRF and the total lead laboratory analytical results correlated well, with a correlation coefficient of 0.87 (Appendix E). Field duplicate soil samples were collected for at least one in ten samples for field screening with the XRF. All duplicate samples field screened except for one were within 15 percent of the

original soil sample measured. Additionally, the measurement error for the XRF was low, generally between ± 2 mg/kg and ± 10 mg/kg with one exception. Sample SLRC040003 indicated a lead concentration of $2,122 \pm 20$ mg/kg. This area was excavated and the soils removed as described above. The low XRF measurement error was achieved through thorough homogenization of the samples and extended x-ray beam time.

2.2.2 Cultural Artifacts

During the excavation activities, general refuse-type materials were unearthed, logged, and given to the USCG. The materials found included multiple rusty nails and broken pieces of porcelain that appeared to have been plates, broken glass, and fragments of clay tile. Additionally, two hollow logs were found, one in the lawn area to the east of the building in Excavation 4 and one in the northern portion of Excavation 5. Both logs were approximately 6 inches in diameter. Sections of the log in Excavation 4 were removed during excavation; the location of the log was noted; and the log sections were given to the USCG for inspection. The log sections were subsequently placed inside the Old Station Building for storage. The log encountered in Excavation 5 contained a number of wires and was left in place. Documentation, including photographs and a map showing the locations of the logs encountered, was sent by the USCG to the SHPO in a letter dated October 15, 2009.

2.2.3 Soil Transport and Disposal Management

The impacted soil was directly loaded into roll-off boxes during the removal action to eliminate the need for stockpiling soils. Three 20-yard capacity roll-off boxes of nonhazardous soils were transported by K&D to the Allied Waste Landfill in Manistee, Michigan for disposal. The roll-off boxes were removed from the Site and transported to the disposal facility on August 18, 2009; August 24, 2009; and August 27, 2009. The trucks followed a prescribed transportation route to the disposal facility.

The USCG reviewed, approved, and signed all waste profiles and manifests prior to shipping the soil from the Site in accordance with Resources Conservation and Recovery Act (RCRA) and Department of Transportation (DOT) regulations. The oversight contractor, K&D, obtained weight tickets and manifests from each truckload of nonhazardous soil transported from the Site to the landfill. Copies of all transport and disposal documentation are provided in Appendix C and will be kept on file by the USCG.

2.2.4 Shoring and Dewatering

The maximum depth of the excavations was 2 feet bgs and did not extend below the groundwater table, which is approximately 5 feet bgs. Therefore, shoring and dewatering was not necessary during the excavation.

2.2.5 Health and Safety

Health and safety activities were conducted in accordance with the Health and Safety Plan (HASP) included in the RAWP. Prior to beginning work, the on-site contractors reviewed and signed the Site-specific HASP. ARCADIS conducted daily Tailgate Health and Safety Meetings with on-site personnel, and the meetings were documented on Daily Tailgate Safety Briefing Forms.

Air monitoring with a personal dust monitor (PDM) as described in the RAWP was performed throughout the entire soil removal action because of the toxicity of lead dust. Air quality was monitored in the work zone and at designated monitoring stations at the perimeter of the site. The perimeter monitoring stations were selected based on the primary wind direction during the removal action. During the removal activities, the air monitoring action level of 0.050 milligrams per cubic meter (mg/m^3) identified in the HASP was exceeded within the work zone several times because of the dry sandy conditions. Work was immediately stopped each time, and dust suppression measures were implemented as described in the RAWP. Clean water was obtained by hose from the Old Station building, and the excavation areas were sprayed lightly with clean water as needed to minimize dust emissions. The dust suppression was effective at minimizing dust emissions and keeping the dust concentration in the work zone below the action level. The action level was not exceeded at any of the air monitoring stations at the perimeter of the work zone during the removal activities.

2.3 Confirmation Soil Sampling Results

2.3.1 Soil Sample Results

As prescribed in Section 2.2 of the RAWP, a total of 32 removal confirmation soil samples were collected from the excavated area. The samples were submitted to TestAmerica in Watertown, Wisconsin and analyzed for fine- and coarse-fraction lead by USEPA Method 6010 in accordance with the QAPP (ARCADIS U.S., Inc. 2008c) and QAPP Addendum (ARCADIS U.S., Inc. 2009c). The laboratory analytical results for total lead in final removal confirmation sidewall and bottom samples ranged from 10

mg/kg to 261 mg/kg. None of the removal confirmation samples contained reported concentrations of lead above the RAO of 400 mg/kg in the individual fine or coarse fractions or in the calculated total lead result based on the representative weight of the two fractions. Therefore, additional excavation was not necessary. The laboratory analytical report is included in Appendix F and results are summarized in Table 2.

Two samples of backfill material (one from the backfill sand and one from the topsoil) were collected, submitted to TestAmerica and analyzed for total lead. Both backfill samples were composite samples collected from three discrete locations within the backfill piles placed at the Site prior to backfilling the excavations. The backfill samples exhibited total lead concentrations of 3.1 mg/kg (sand) and 8.6 mg/kg (topsoil). The laboratory analytical report is provided in Appendix F.

The methods and procedures for collecting and analyzing soil samples were followed as outlined in the QAPP (ARCADIS U.S., Inc. 2008c), QAPP Addendum (ARCADIS U.S., Inc. 2009c) and RAWP (ARCADIS U.S., Inc. 2009b). In addition to the confirmation samples collected, quality assurance/quality control (QA/QC) samples were collected, including three blind duplicates, three equipment blanks, and two matrix spike/matrix spike duplicates (MS/MSDs), and submitted to TestAmerica for analysis in accordance with the QAPP (ARCADIS U.S., Inc. 2008c) and QAPP Addendum (ARCADIS U.S., Inc. 2009c).

2.3.2 Data Validation

The laboratory analytical reports were reviewed and validated in accordance with the QAPP and QAPP Addendum for the Old Station Ludington removal action, the USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (2002) and Region II SOPs that apply to USEPA Method 6010 and 6020A, laboratory control limits, and professional judgment. As outlined in the QAPP (ARCADIS U.S., Inc. 2008c), Level III analytical reporting was requested for all removal confirmation samples, and a Level III validation was performed on the removal confirmation results. The laboratory's overall system performance and data quality were acceptable and within the guidelines specified in the analytical method. The data validation reports (DVRs) are included in Appendix F.

2.4 Decontamination Procedures

Equipment that came into contact with the impacted soil was decontaminated according to the SOP for decontamination provided in the RAWP (ARCADIS U.S., Inc.

2009b). Excavation equipment buckets and tires were brushed down, and the residual soil was collected and placed in the lined roll-off boxes for disposal. The stainless-steel spoon used to collect soil samples was decontaminated using sprayer bottles of detergent solution and distilled water.

2.5 Site Restoration

Expedited laboratory analysis was performed on the confirmation samples to ensure that additional excavation was not needed prior to completing the on-site removal action activities. Restoration of the excavated areas at the Site occurred on August 4 and 5, 2009. The excavations were backfilled with sand from the bottom of the excavation to approximately 3 inches bgs. Prior to the backfilling of Excavation 1, the cracked conduits were repaired with schedule 40 polyvinyl chloride pipe.

In Excavation 1, Excavation 3, and Excavation 4, the remaining 3 inches was backfilled with topsoil, then grass seed was spread, and straw mats were placed on the surface to prevent erosion. These areas were watered initially prior to demobilizing from the Site, and USCG personnel have continued active watering of the grass. The silt fence and filter fabric were removed from this area on October 15, 2009.

In Excavation 2 and Excavation 5, landscape fabric and decorative landscaping rock were used to restore the areas to previous conditions. The silt fence was removed from this area upon completion of the restoration as no vegetative cover was needed. Photo documentation of site restoration activities is included in Appendix B.

2.6 Site Survey

On July 24, 2009 following soil removal activities, the final excavation limits (lateral extent and depth) were surveyed by licensed surveyors Nordlund and Associates of Ludington, Michigan using traditional survey techniques according to procedures defined in the RAWP. At the request of USCG, the eastern and western boundaries of the property containing both the current Station Building and the Old Station Building were also surveyed and marked. The surveyed excavation limits and property lines were used to update the Site plan and are depicted on Figure 4.

Following the survey of the Site, it was noted that a portion of Excavation 4 extended onto the neighboring Starboard Tack Condominiums property east of the Site. Representatives of the Condominium Association were contacted following the survey and discussed the excavation and plan for restoration with USCG on-site. The area of

excavation on the Starboard Tack Condominiums property was restored to pre-excavation condition as described in Section 2.5.

2.7 Groundwater Sampling

Three groundwater monitoring wells were installed in August 2008 during Site characterization activities based on the placement criteria presented in the Field Sampling Plan (FSP) (ARCADIS U.S., Inc. 2008d). Monitoring wells were designated MW-01, MW-02, and MW-03 (see Figure 5). The location for Monitoring Well MW-01 was selected for obtaining a background sample, and Monitoring Wells MW-02 and MW-03 were located downgradient of the impacted areas. The monitoring wells were installed using hollow-stem augers, screened from 3 to 8 feet bgs, and developed according to procedures described in the FSP. Monitoring Wells MW-01, MW-02, and MW-03 were sampled quarterly for one year as described in the FSP (ARCADIS U.S., Inc. 2008d) and EE/CA (ARCADIS U.S., Inc. 2009a).

2.7.1 Groundwater Sample Collection

Quarterly groundwater sampling events were conducted in August 2008, November 2008, February 2009, and May 2009. The groundwater samples were collected for laboratory analysis using a peristaltic pump under low-flow purging and sampling conditions as described in the procedures defined in the FSP (ARCADIS U.S., Inc. 2008d) and QAPP (ARCADIS U.S., Inc. 2008c). Dissolved lead samples were field filtered and preserved at the time of sample collection. Samples were submitted for laboratory analysis of total and dissolved lead according to USEPA Method 6020A in accordance with the QAPP Addendum (ARCADIS U.S., Inc. 2009c).

As described in the QAPP (ARCADIS U.S., Inc. 2008c) and QAPP Addendum (ARCADIS U.S., Inc. 2009c), duplicate samples equipment blanks and matrix spike/matrix spike duplicate samples were collected and submitted to the laboratory for analysis.

2.7.2 Groundwater Sample Results

Groundwater sample results are presented in Table 3 and presented on Figure 5. None of the groundwater samples collected during the quarterly sampling events contained concentrations of total or dissolved lead above the groundwater screening level of 4 micrograms per liter ($\mu\text{g/L}$) defined in the EE/CA (ARCADIS U.S., Inc. 2009a). The August 2008 groundwater sampling results were presented in the EE/CA

(ARCADIS U.S., Inc. 2009a). Groundwater analytical results for the November 2008, February 2009 and May 2009 sampling were submitted for Level III data validation according to the QAPP (ARCADIS U.S., Inc. 2008c). Laboratory reports and DVRs are included in Appendix F.

2.7.3 Monitoring Well Abandonment

Because no groundwater impacts were reported at the Site, the monitoring wells installed during the Site characterization activities will be abandoned and documented in accordance with State requirements upon completion of the project. The well casing and concrete pad will be removed and bentonite chips will be used to backfill the holes. The surface will be finished with topsoil and grass seed.

3. Conclusions

Lead-impacted soil resulting from the historical application and subsequent weathering of lead-based exterior paint was encountered in the near-surface soils around the structure at the Old Station Ludington. A removal action was conducted in accordance with the USEPA's *Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA* (1993). The primary objective of the removal action was to protect public health and welfare and the environment, thereby facilitating the transfer of the remaining property from the federal inventory to the City of Ludington. An RAO of 400 mg/kg was selected for the Site, and this RAO is protective of the anticipated future land use (e.g., park or museum). The soil removal activities took place from July 20 through 24, 2009, and Site restoration activities took place on August 4 and 5, 2009.

Approximately 39.4 tons of nonhazardous lead-impacted soil were excavated from the Site and transported in lined roll-off boxes to the Allied Waste Landfill in Manistee, Michigan for disposal. Soil samples were collected from the excavations' bottoms and sidewalls for laboratory analysis of fine- and coarse-fraction lead. Laboratory analytical results of the soil samples indicated lead concentrations were below the RAO in all of the confirmation samples. The excavations were then backfilled and either seeded and covered with a straw mat to prevent erosion or covered with landscaping fabric and rock.

The USCG, acting as the lead agency and in compliance with the NCP and CERCLA 120 (h), has achieved the RAO as outlined and set forth in the EE/CA and RAWP for the Old Station Ludington. The current and anticipated future use of this property is recreational (e.g., park or museum). The achieved RAO is protective of public health

and welfare and the environment for this anticipated land use. Therefore, the Site is suitable for transfer based on compliance with the above CERCLA requirements.

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ARCADIS

**Removal Action
Completion Report**

Old Station Ludington
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TABLES

Table 1a. Federal and State Chemical-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered Guidance, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan.

Constituent of Concern and Media	Authority	Act	Statute, Regulation, Administrative Code, or Guidance Document	Status	Synopsis of Requirement, Criteria, or Guidance
Lead in Soil	Federal Regulatory Requirement and/or Criteria	NA	NA	NA	Because the site is intended for recreational use, there are no Applicable or Relevant and Appropriate Criteria.
	Federal Advisories, Guidance, and Training Material	NA	Revised Interim Soil Lead Guidance for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Sites and Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities, OSWER Directive #9355.4-12 (United States Environmental Protection Agency 1994) <u>OSWER Directive 9355.4-12</u> Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, OSWER Directive 9200.4-27P (United States Environmental Protection Agency 1998) Clarification Memo	To Be Considered	These documents are non-promulgated guidance to be used as guidelines for evaluating site investigation data. Describes how to develop site-specific Preliminary Remediation Goals (PRGs) at CERCLA Sites and Media Cleanup Standards (MCSs) at RCRA Corrective Action facilities for residential land use. They describe a plan for soil lead cleanup at CERCLA sites and RCRA Corrective Action facilities that have multiple sources of lead. The recommended Screening Level for Lead in Soil is 400 milligrams per kilogram (mg/kg) for generic residential land use (assumes bare soil in child's play area as the exposure scenario).
	State Requirements and/or Criteria	Natural Resources Environmental and Protection Act of 1994, Public Act 451 as amended (NREPA)	Michigan Compiled Law 324, Part 201, Michigan Administrative Code (MAC) Rules 299.5706, 299.5707, 299.5718 through 299.5726, 299.5732, 299.5746, 299.5748, 299.5750, and 299.5752 <u>MAC Rules for Part 201</u>	Relevant and Appropriate*	These are promulgated statutes and rules associated with cleanup criteria. See Tables 2 and 3 in the MAC Rules for Generic Criteria and Screening Levels for each land use category. Generic Criteria for Lead in soil are: <ul style="list-style-type: none">• Residential and Commercial I, Commercial III, and Commercial IV = 400 mg/kg• Recreational = NA (use Rule 299.5732 for site-specific criterion calculation)• Commercial II = 900 mg/kg• Drinking Water Protection = 700 mg/kg• Groundwater/Surface-Water Interface Protection = Varies depending on pH and hardness of receiving water (see footnote G in R299.5750) Alternatively, development of a site-specific limited criterion for lead is allowed by Rule 299.5732 and is calculated based on site-specific exposure pathway evaluation, exposure controls measures, and land-use considerations.
	State Advisories, Guidance, and Training Material	NA	Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Divisions (RRD) Operational Memorandum Number 1 (Part 201 Cleanup Criteria) MDEQ RRD Op Memo 1	To Be Considered*	This document is a non-promulgated memorandum prepared by the MDEQ to provide guidance on satisfying the cleanup criteria requirements under NREPA Part 201; it defines land-use categories and provides updated and interim cleanup criteria and screening levels. The attachments to the operational memorandum provide technical support documentation for the chemical physical data and algorithms used to calculate the criteria.
		NA	MDEQ RRD Operational Memorandum Number 2 (Part 201 Sampling and Analysis Guidance) MDEQ RRD Op Memo 2	To Be Considered*	This document is a non-promulgated memorandum prepared by the MDEQ to provide guidance on target detection limits and designated analytical methods; soil leaching methods; sample preservation; sampling, handling, and holding times; and the collection of samples for comparison to generic Criteria
Lead in Air	Federal Regulatory Requirement and/or Criteria	Clean Air Act (CAA)	42 USC 7409 <u>42 USC 7409</u> 40 CFR 50.12 and Appendix G to Part 50 <u>40 CFR 50.12</u> <u>Appendix G to Part 50</u>	Applicable	These rules establish emissions limits for lead and describe test methods and procedures to determine emissions. The national primary and secondary ambient air quality standards for lead and its compounds, measured as elemental lead by a reference method based on Appendix G to 40 CFR 50, or by an equivalent method, are 1.5 micrograms per cubic meter (µg/m ³), maximum arithmetic mean averaged over a calendar quarter.
	Federal Advisories, Guidance, and Training Material	None	None	None	None
	State Regulatory Requirement and/or Criteria	NA	Michigan Air Pollution Control Rules Part 2. Air Use Approval Exemptions R336.1290 <u>Part 2 Air Use Approval Exemptions</u>	Applicable*	Establishes exemption from permit to install for emission units with limited emissions. Establishes thresholds and limits by pollutant type and recordkeeping requirements.
	State Advisories and Guidance	None	None	None	None

See notes on page 2.

Table 1a. Federal and State Chemical-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered Guidance, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan.

Constituent of Concern and Media	Authority	Act	Statute, Regulation, Administrative Code, or Guidance Document	Status	Synopsis of Requirement, Criteria, or Guidance
Lead in Water	Federal Regulatory Requirement and/or Criteria	NA	NA	NA	Groundwater is not impacted above any Applicable or Relevant and Appropriate Criteria.
	Federal Advisories, Guidance, and Training Material	NA	NA	NA	Groundwater is not impacted above any Applicable or Relevant and Appropriate Criteria.
	State Regulatory Requirement	NREPA, Act 451 of 1994	Michigan Compiled Laws Chapter 324, Part 201 MAC Rules, Groundwater Cleanup Criteria R299.5706, R299.5708, R299.5709, R299.5710, R299.5712, R299.5716, R299.5730, R299.5732, and R299.5744 <u>MAC Part 201 Rules</u>	NA	Groundwater and surface water are not impacted above any Applicable or Relevant and Appropriate Criteria.
		NA	MAC Rules Water Resources Protection (Part 31, Section 324.3109) <u>MAC Part 31 Rules</u>	NA	Groundwater and surface water are not impacted above any Applicable or Relevant and Appropriate Criteria.
	State Advisories, Guidance, and Training Material	NA	RRD Operational Memorandum Number 1 (Part 201 Cleanup Criteria) <u>MDEQ RRD Op Memo 1</u>	NA	Groundwater and surface water are not impacted above any Applicable or Relevant and Appropriate Criteria.
		NA	MDEQ RRD Operational Memorandum Number 2 (Part 201 Sampling and Analysis Guidance) <u>MDEQ RRD Op Memo 2</u>	NA	Groundwater and surface water are not impacted above any Applicable or Relevant and Appropriate Criteria.
		NA	MDEQ RRD Operational Memorandum Number 5 (Part 201 Groundwater/Surface-Water Pathway Criteria) <u>MDEQ RRD Op Memo 5</u>	NA	Groundwater and surface water are not impacted above any Applicable or Relevant and Appropriate Criteria.

Notes:
TBD To Be Determined.
NA Not Applicable.
* The USCG solicited Applicable or Relevant and Appropriate Requirements (ARARs) from the State of Michigan in a letter dated September 25, 2008. A response from the MDEQ has not been received.
Potential State of Michigan ARARs and To Be Considered (TBCs) have been evaluated based on professional judgment consistent with other Sites in Michigan, where similar removal actions have been performed.

Table 1b. Location-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered Guidance, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan.

Location	Authority	Act	Statute, Regulation, Administrative Code, or Guidance Document	Status	Synopsis of Requirement, Criteria, or Guidance
Federally Owned Property	Federal Regulatory Requirement	National Historic Preservation Act of 1966	National Historic Preservation 16 USC 470 <u>USC 16 Section 470</u> Protection of Historic Properties (36 CFR 800) <u>36 CFR 800</u>	Applicable	These rules require the identification and preservation of historic and archaeological sites. The act created the National Register of Historic Places, the list of National Historic Landmarks, and the State Historic Preservation Offices. Among other things, the act requires federal agencies to evaluate the impact of all federally funded or permitted projects through a process known as a Section 106 Review.
	Federal Advisories, Guidance, and Training Material	None	None	None	None
	State Regulatory Requirement and/or Criteria	None	None	None	None
	State Advisories, Guidance, and Training Material	None	None	None	None

Notes:
TBD To Be Determined.
NA Not Applicable.
* The USCG solicited Applicable or Relevant and Appropriate Requirements (ARARs) from the State of Michigan in a letter dated September 25, 2008. A response from the MDEQ has not been received.
Potential State of Michigan ARARs and To Be Considered (TBCs) have been evaluated based on professional judgment consistent with other Sites in Michigan, where similar removal actions have been performed.

Table 1c. Action-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered Guidance, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan.

Action	Authority	Act or Statute	Regulation, Administrative Code, or Guidance Document	Status	Synopsis
Excavation of Lead Impacted Soil	Federal Regulatory Requirement	Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	Federal Facilities 42 United States Code (USC) 9620	Applicable	These rules require notifications related to hazardous substances prior to the sale or transfer of real property owned by the federal government. This is applicable if a property with residual contamination is transferred.
		as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA)	<u>42 USC 9620</u> Reporting Hazardous Substance Activity When Selling or Transferring Federal Real Property (Title 40 Code of Federal Regulations [CFR] 373) <u>40 CFR 373</u>		
		CERCLA as amended by the 1986 SARA	National Contingency Plan (42 USC 9605) <u>42 USC 9605</u> National Contingency Plan (40 CFR Section 300.400 through 300.415) <u>40 CFR 300</u>	Applicable	These promulgated rules require performing a Removal Site Evaluation and a Removal Action including preparing certain documents (Quality Assurance Project Plan [QAPP], a field sampling plan [FSP], and an engineering evaluation cost analysis [EE/CA]), considering federal and state ARARs, soliciting community involvement and providing notifications prior to the removal action.
		Executive Order 12580 of January 23, 1987, Superfund Implementation	Executive Order 12580- Superfund Implementation Executive Order 12580	Applicable	The Executive Order provides federal agencies, including the United States Coast Guard, the authority to carry out their CERCLA responsibilities under the National Contingency Plan as a lead agency.
		Occupational Safety & Health Administration Act (OSHA) of 1970	Occupational Safety & Health Administration Act (Public Law 91-596 84 STAT. 1590) <u>PL 91-596 OSHA</u> Occupational Safety & Health Administration (29 CFR 1910) <u>29 CFR 1910</u>	Applicable	These regulations specify requirements for health and safety protection for workers exposed to contaminants during hazardous waste site remediation.
		OSHA	Occupational Safety & Health Administration Act (Public Law 91-596 84 STAT. 1590) <u>PL 91-596 OSHA ACT</u> Occupational Safety & Health Administration (29 CFR 1926) <u>29 CFR 1926</u>	Applicable	These regulations specify requirements for health and safety protection for workers at construction sites.
	State Regulatory Requirement	Natural Resources Environmental Protection Act of 1994, Public Act 451 as amended (NREPA)	Soil Conservation, Erosion, and Sedimentation Control Part 91 Michigan Administrative Code (MAC) R323.1702(1), R323.1709 (2), R323.1709 (3), R323.1709 (4), R323.1709 (5) <u>Part 91</u>	Relevant and Appropriate*	These regulations specify requirements for earth change actions including erosion and sedimentation control measures that will effectively reduce accelerated soil erosion and resulting sedimentation. These regulations require the construction of temporary or permanent control measures to remove sediment from run-off water before it leaves the site.
		NREPA	Michigan Compiled Law 324, Part 55 Section 324.5524 Air Pollution Control <u>MCL 324 Part 55</u> MAC Air Pollution Control Rules 336.1370 through 336.1374 <u>Michigan Air Pollution Control Rules</u>	Relevant and Appropriate*	These promulgated statutes and rules are associated with fugitive dust emissions.
	Federal Advisories and Guidance	None	None	None	None.

See notes on page 5.

Table 1c. Action-Specific Applicable or Relevant and Appropriate Requirements and To Be Considered Guidance, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan.

Action	Authority	Act or Statute	Regulation, Administrative Code, or Guidance Document	Status	Synopsis
Excavation of Lead Impacted Soil (continued)	State Advisories and Guidance	NA	Michigan Department of Environmental Quality (MDEQ) Sampling Strategies and Statistical Training Materials for Part 201 Clean up Criteria (S3TM) S3TM Guidance	To Be Considered*	This document includes non-promulgated training materials prepared by the MDEQ to provide recommendations on sampling of environmental media for various sampling objectives under NREPA Part 201, determine when it is appropriate to use statistics, and identify which statistical methods to use for comparing data to Part 201 cleanup criteria.
		NA	MDEQ Water Bureau Soil Erosion and Sedimentation (SES) Control Program, Soil Erosion and Sedimentation Training Manual SES Training Manual	To Be Considered*	This document includes non-promulgated guidance material prepared to assist in the design and construction of erosion and sedimentation control measures.
		NA	MDEQ Remediation and Redevelopment Division (RRD) Operational Memorandum Number 2 (Part 201 Sampling and Analysis Guidance) MDEQ RRD Op Memo 2	To Be Considered*	This document is a non-promulgated memorandum prepared by the MDEQ to provide guidance on target detection limits and designated analytical methods; soil leaching methods; sample preservation, sampling, and handling and holding times; and the collection of samples for comparison to generic criteria.
			MDEQ RRD Operational Memorandum Number 4 (Site Characterization and Remediation Verification) MDEQ RRD Op Memo 4	To Be Considered*	This document is a non-promulgated memorandum prepared by the MDEQ to provide direction for generating data for facility characterization (nature, extent, and impact of a release or threat of a release) and monitoring to support remedial decisions and assessing exposure pathways for compliance with cleanup criteria. The sampling strategies identified in this document represent acceptable approaches and ranges of appropriate assumptions that are intended to support consistent exercise of professional judgment in a manner that produces satisfactory outcomes. Alternative approaches may be used if the person proposing the alternative demonstrates that the approach meets all requirements of the statute and rules.
	Local Regulatory Requirement	None	None	None	None

Notes:
TBD To Be Determined.
NA Not Applicable.
* The U.S. Coast Guard solicited Applicable or Relevant and Appropriate Requirements (ARARs) from the State of Michigan in a letter dated September 25, 2008. A response from the MDEQ has not been received.
Potential State of Michigan ARARs and To Be Considered (TBCs) have been evaluated based on professional judgment consistent with other Sites in Michigan, where similar removal actions have been performed.

Table 2. Confirmation Sample Analytical Results and Field Screening Results, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan

Excavation Area	Sample ID	Date	Sample Type	Depth (ft bgs)	Laboratory Results			Field Screening Results	
					Lead - fine (mg/kg)	Lead - coarse (mg/kg)	Total Lead (mg/kg)	Lead XRF Reading (ppm)	Lead XRF Measurement Error (\pm ppm)
Excavation 1	SLRC 010001	7/21/2009	Bottom Field Screening	1.0	NA	NA	NA	16	2
Excavation 1	SLRC 010002	7/21/2009	Bottom Field Screening	1.0	NA	NA	NA	21	3
Excavation 1	SLRC 010002	7/21/2009	Bottom Field Screening Duplicate	1.0	NA	NA	NA	22	3
Excavation 1	SLRC 010003	7/21/2009	Bottom Field Screening	1.0	NA	NA	NA	55	3
Excavation 1	SLRC 010004	7/21/2009	Bottom Confirmation	1.5	26	14	22	30	3
Excavation 1	SLRC 010005	7/21/2009	Bottom Confirmation	1.0	47	66	59	42	3
Excavation 1	SLRC 010006	7/21/2009	Sidewall Confirmation	0.5	310	170	240	260	5
Excavation 1	SLRC 010007	7/21/2009	Sidewall Confirmation	0.5	49	43	45	33	3
Excavation 1	SLRC 010008	7/21/2009	Sidewall Field Screening	1.0	NA	NA	NA	844	10
Excavation 1	SLRC 010008	7/21/2009	Sidewall Field Screening Duplicate	1.0	NA	NA	NA	753	11
Excavation 1	SLRC 010009	7/21/2009	Sidewall Field Screening	0.5	NA	NA	NA	279	6
Excavation 1	SLRC 010009	7/21/2009	Sidewall Field Screening	1.0	NA	NA	NA	137	4
Excavation 1	SLRC 010010	7/21/2009	Sidewall Field Screening	1.0	NA	NA	NA	60	3
Excavation 1	SLRC 010011	7/21/2009	Sidewall Field Screening	1.0	NA	NA	NA	176	5
Excavation 1	SLRC 010012	7/22/2009	Sidewall Confirmation	0.5	79	42	63	82	4
Excavation 2	SLRC 020001	7/22/2009	Sidewall Confirmation	0.5	54	23	35	38	3
Excavation 2	SLRC 020002	7/22/2009	Sidewall Confirmation	0.5	17	11	13	17	2
Excavation 2	SLRC 020003	7/22/2009	Sidewall Field Screening	0.5	NA	NA	NA	236	5
Excavation 2	SLRC 020004	7/22/2009	Bottom Confirmation	1.0	47	20	31	34	3
Excavation 2	SLRC 020005	7/22/2009	Bottom Confirmation	1.0	130	53	83	75	3
Excavation 2	SLRC 020005	7/22/2009	Bottom Confirmation Duplicate	1.0	78	44	57	65	3
Excavation 2	SLRC 020006	7/22/2009	Sidewall Confirmation	0.5	130	67	91	89	4
Excavation 3	SLRC 030001	7/23/2009	Sidewall Confirmation	0.5	35	13	26	24	2
Excavation 3	SLRC 030002	7/23/2009	Sidewall Confirmation	0.5	250	68	200	132	4
Excavation 3	SLRC 030002	7/23/2009	Sidewall Confirmation Duplicate	0.5	130	120	120	128	4
Excavation 3	SLRC 030003	7/23/2009	Sidewall Confirmation	0.5	12	12	12	10	2
Excavation 3	SLRC 030004	7/23/2009	Sidewall Confirmation	0.5	180	74	110	160	5
Excavation 3	SLRC 030005	7/23/2009	Bottom Confirmation	1.0	24	13	18	25	3
Excavation 3	SLRC 030006	7/23/2009	Bottom Confirmation	1.0	150	36	94	261	4
Excavation 3	SLRC 030006	7/23/2009	Bottom Confirmation Duplicate	1.0	NA	NA	NA	102	4
Excavation 4	SLRC 040001	7/22/2009	Sidewall Confirmation	0.5	260	75	150	158	5
Excavation 4	SLRC 040002	7/22/2009	Sidewall Confirmation	0.5	100	43	66	65	4
Excavation 4	SLRC 040003	7/22/2009	Sidewall Field Screening	0.5	NA	NA	NA	2122	20
Excavation 4	SLRC 040004	7/22/2009	Sidewall Confirmation	0.5	330	210	260	243	5
Excavation 4	SLRC 040005	7/22/2009	Sidewall Confirmation	0.5	160	46	81	93	5
Excavation 4	SLRC 040006	7/22/2009	Sidewall Confirmation	0.5	370	120	210	223	7
Excavation 4	SLRC 040007	7/22/2009	Sidewall Confirmation	0.5	78	42	56	60	4
Excavation 4	SLRC 040007	7/22/2009	Sidewall Confirmation Duplicate	0.5	110	22	53	51	3
Excavation 4	SLRC 040008	7/22/2009	Bottom Confirmation	1.0	120 J	33	93	63	4
Excavation 4	SLRC 040009	7/22/2009	Bottom Field Screening	1.0	NA	NA	NA	314	6
Excavation 4	SLRC 040010	7/23/2009	Sidewall Confirmation	1.0	65	38	47	50	3
Excavation 4	SLRC 040011	7/23/2009	Bottom Confirmation	2.0	85	24	61	24	2

See notes on page 2.

Table 2. Confirmation Sample Analytical Results and Field Screening Results, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan

Excavation Area	Sample ID	Date	Sample Type	Depth (ft bgs)	Laboratory Results			Field Screening Results	
					Lead - fine (mg/kg)	Lead - coarse (mg/kg)	Total Lead (mg/kg)	Lead XRF Reading (ppm)	Lead XRF Measurement Error (\pm ppm)
Excavation 5	SLRC 050001	7/23/2009	Sidewall Confirmation	0.5	130	220	200	151	5
Excavation 5	SLRC 050002	7/23/2009	Sidewall Confirmation	0.5	170	180	180	156	5
Excavation 5	SLRC 050003	7/23/2009	Sidewall Confirmation	0.5	23	31	29	26	2
Excavation 5	SLRC 050004	7/23/2009	Bottom Confirmation	1.0	100	72	82	81	4
Excavation 5	SLRC 050005	7/23/2009	Sidewall Confirmation	0.5	97	130	120	115	4
Excavation 5	SLRC 050006	7/23/2009	Sidewall Confirmation	0.5	180 J	250 J	230	186	4
Excavation 5	SLRC 050007	7/23/2009	Bottom Confirmation	1.0	200	180	190	141	5

Notes:

All soil samples were prepared and analyzed in accordance with the QAPP (ARCADIS U.S., Inc 2008c), FSP (ARCADIS U.S., Inc. 2008d), and QAPP Addendum (ARCADIS U.S., Inc. 2009c).

ft bgs Samples were excavated.
 J Feet below ground surface.
 mg/kg The compound was positively identified; however, the associated numerical value is an estimated concentration only.
 NA Milligrams per kilogram.
 ppm Not applicable.
 XRF Parts per million.
 X-Ray fluorescence.

Table 3. Groundwater Analytical Results, U.S. Coast Guard, Old Station Ludington, Ludington, Michigan

Sample ID	Date	Screen Interval (ft bgs)	Lead (µg/L)	Dissolved Lead (µg/L)	Hardness (mg/L)
MW-01	8/18/2008	3 - 8	0.14 J	< 0.4	200
MW-01	11/12/2008	3 - 8	< 0.4	< 0.4	NS
MW-01	2/9/2009	3 - 8	< 0.4	0.13 J	NS
MW-01	5/18/2009	3 - 8	< 0.4	<0.4	NS
MW-02	8/18/2008	3 - 8	< 0.4	< 0.4	130
MW-02	11/12/2008	3 - 8	< 0.4	< 0.4	NS
MW-02	2/9/2009	3 - 8	< 0.4	< 0.4	NS
MW-02	5/18/2009	3 - 8	< 0.4	< 0.4	NS
MW-03	8/18/2008	3 - 8	0.37 J	0.35 J	220
MW-03	11/12/2008	3 - 8	< 0.4	< 0.4	NS
MW-03	2/9/2009	3 - 8	< 0.4	< 0.4	NS
MW-03	5/18/2009	3 - 8	<0.4 UB	< 0.4	NS

Notes:

Analytical results are compared to the Site-Specific Screening Level of 4 µg/L.

Samples were analyzed in accordance with USEPA Method 6020A for total and dissolved lead and in accordance with SM 2340B for hardness.

ft bgs

Feet below ground surface.

J

The compound was positively identified; however, the associated numerical value is an estimated concentration only.

mg/L

Milligrams per liter.

NS

Not Sampled.

UB

Compound considered non-detect at the listed value due to associated blank contamination.

µg/L

Micrograms per liter.

FIGURES



UNITED STATES COAST GUARD
 OLD STATION LUDINGTON
 LUDINGTON, MICHIGAN

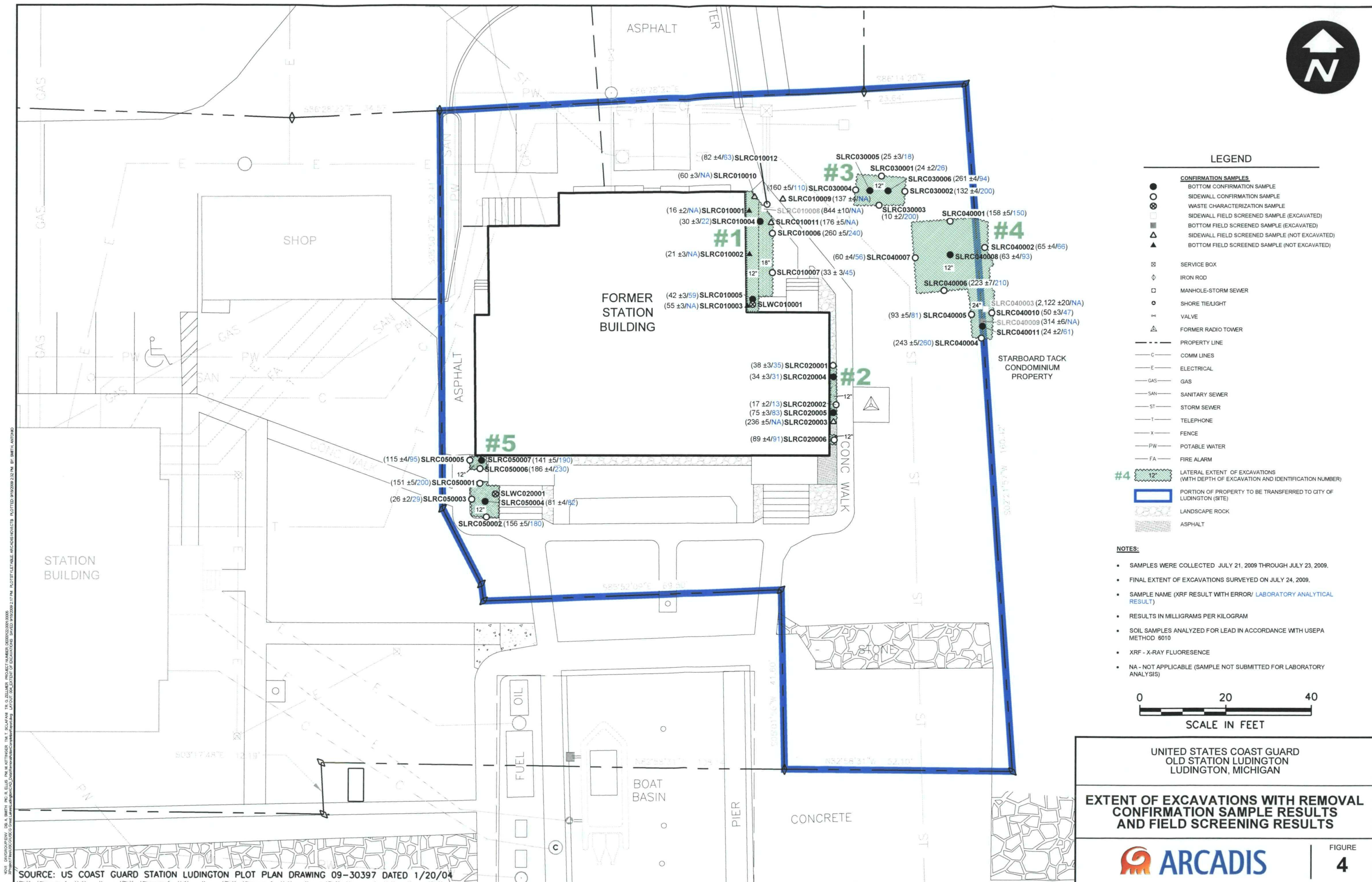
SITE LOCATION

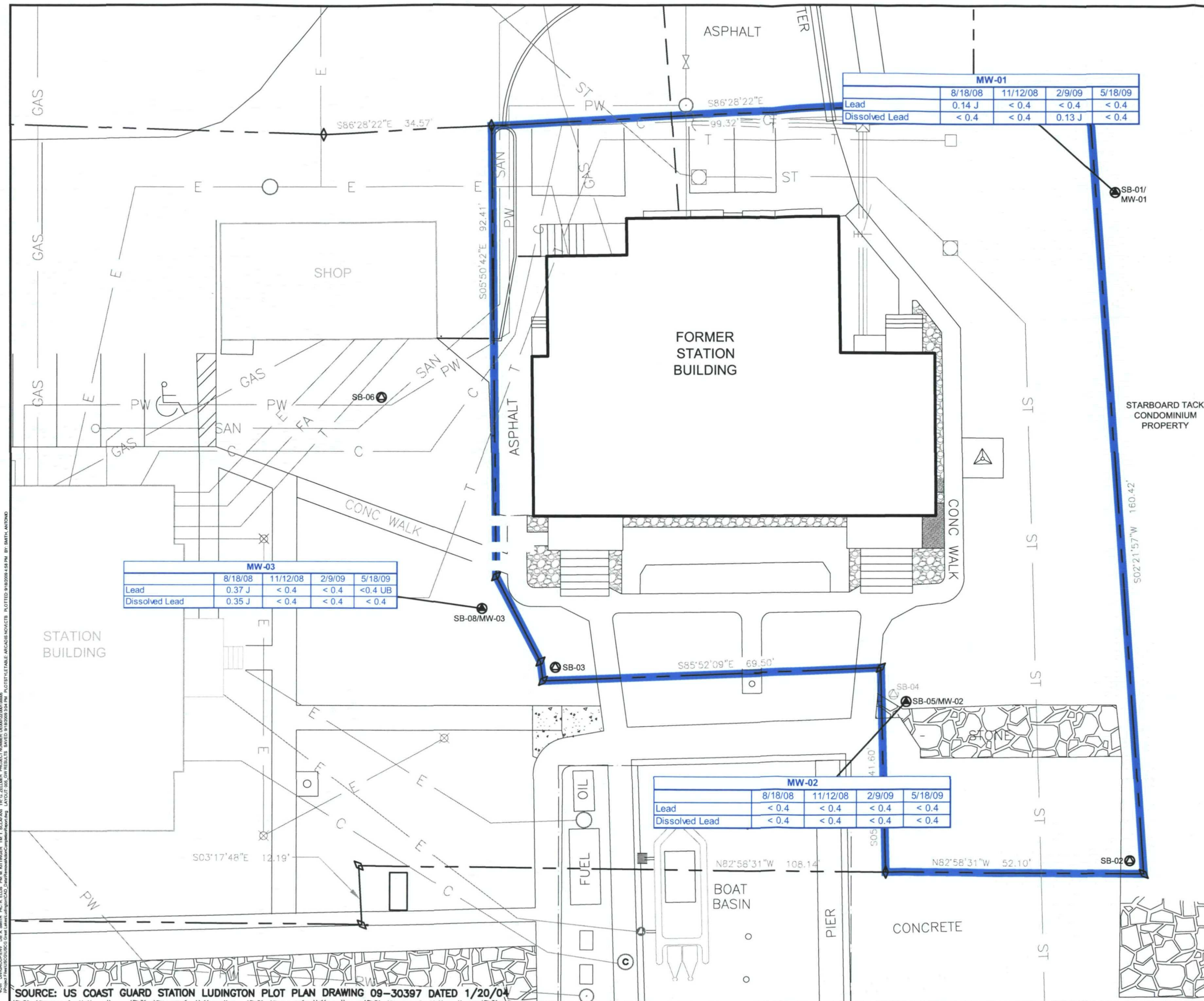


FIGURE

1





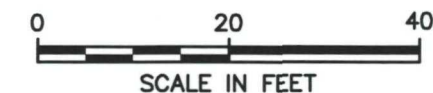


LEGEND

- SOIL BORING
- ⊙ SOIL BORING (ABANDONED/DESTROYED)
- MONITORING WELL
- SERVICE BOX
- ◇ IRON ROD
- ⊕ LIGHT POLE
- MANHOLE-STORM SEWER
- ⊙ POWER POLE
- SHORE TIE/LIGHT
- ⋈ VALVE
- ▲ FORMER RADIO TOWER
- PROPERTY LINE
- C- COMM LINES
- E- ELECTRICAL
- GAS- GAS
- SAN- SANITARY SEWER
- ST- STORM SEWER
- T- TELEPHONE
- X- FENCE
- PW- POTABLE WATER
- FA- FIRE ALARM
- ▭ PORTION OF PROPERTY TO BE TRANSFERRED TO CITY OF LUDINGTON (SITE)
- ▨ LANDSCAPE ROCK
- ▩ ASPHALT

NOTES:

1. ANALYTICAL RESULTS ARE FROM THE AUGUST 2008, NOVEMBER 2008, FEBRUARY 2009 AND MAY 2009 GROUNDWATER SAMPLING EVENTS.
2. GROUNDWATER SAMPLES WERE ANALYZED IN ACCORDANCE WITH USEPA METHOD 6020A.
3. CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L).
4. J - THE COMPOUND IS POSITIVELY IDENTIFIED; HOWEVER, THE ASSOCIATED NUMERICAL VALUE IS AN ESTIMATED CONCENTRATION ONLY.
5. UB - COMPOUND CONSIDERED NON-DETECT AT THE LISTED VALUE DUE TO ASSOCIATED BLANK CONTAMINATION.
6. SITE-SPECIFIC SCREENING LEVEL FOR LEAD IS 4µg/L.



UNITED STATES COAST GUARD
OLD STATION LUDINGTON
LUDINGTON, MICHIGAN

GROUNDWATER ANALYTICAL RESULTS



FIGURE
5

ARCADIS

Appendix A

Public Participation Correspondence



JENNIFER M. GRANHOLM
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
CADILLAC DISTRICT OFFICE



STEVEN E. CHESTER
DIRECTOR

May 21, 2009

Mr. Frank A. Blaha
Chief, Environmental Compliance
United States Coast Guard
Civil Engineering Unit
1240 East Ninth Street, Room 2179
Cleveland, OH 44199-2060

Dear Mr. Blaha:

Subject: Removal Action Work Plan, April 3, 2009
U.S. Coast Guard Old Station Ludington

Staff of the Michigan Department of Environmental Quality, Remediation and Redevelopment Division has reviewed the Removal Action Work Plan. The plan is acceptable and appropriate and does comply with our regulations.

Please contact me at the Cadillac District office should you have any questions or concerns regarding this matter.

Sincerely,

John D. Vanderhoof
Environmental Quality Analyst
Remediation and Redevelopment Division
231-876-4459

Martin, Michele

From: Gregory.O.Carpenter@uscg.mil on behalf of Carpenter, Gregory [Gregory.O.Carpenter@uscg.mil]
Sent: Friday, June 12, 2009 2:05 PM
To: Thompson.Owen@epamail.epa.gov
Cc: Blaha, Frank; Ellis, Rob; Sclafani, Troy
Subject: Old STA Ludington EE/CA Public Notice

Owen,

To date I have received only one comment, a compliance approval letter from MI DEQ for the RAWP, for the Old STA Ludington EE/CA and RAWP public notice and comment period.

The public notice comment period for the Old STA Ludington was from May 1 thru May 31 2009. I allowed another two weeks period for late comments. As of today, I am closing the comment period on the public notice.

Field work is tentatively scheduled for the weeks of July 20th and 27th 2009.

Let me know if you have any questions or concerns. Thank you.

Gregory O. Carpenter, P.G.
Environmental Engineer
U.S. Coast Guard
Civil Engineering Unit Cleveland
1240 East Ninth Street, Rm. 2179
Cleveland, Ohio 44199-2060
E-mail: Gregory.O.Carpenter@uscg.mil
Phone: (216) 902-6219
Fax (216) 902-6277

ARCADIS

Appendix B

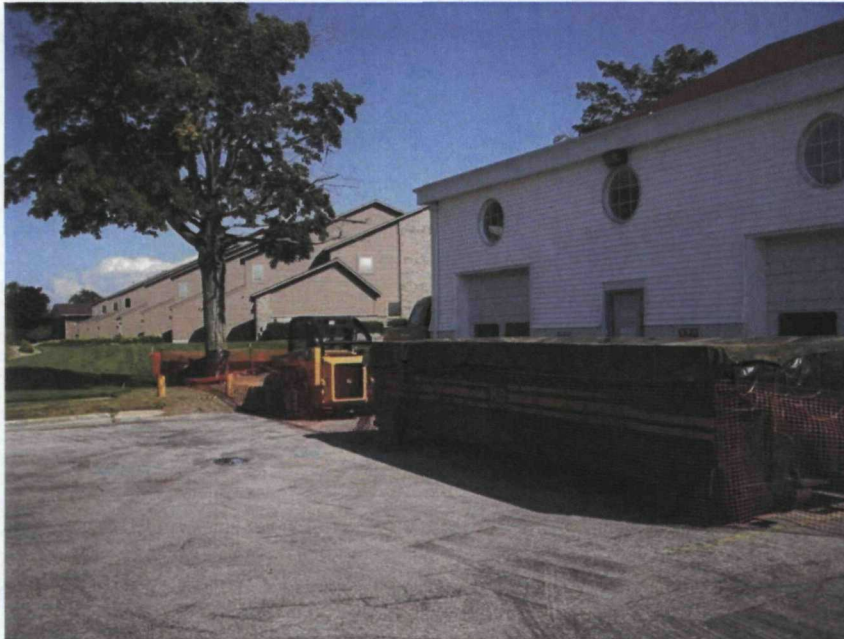
Photographic Documentation
Removal and Restoration Activities

U.S. Coast Guard
Old Station Ludington

Removal and Restoration Activities
Photographic Documentation

July 20, 2009 – August 5, 2009





View of equipment
staging area and work
zone fencing.



View of sampling and
field screening
workstation.



View of soil removal activities at
Excavation 1.



View of soil removal activities at
Excavation 2.



View of soil removal activities
at Excavation 3 and
Excavation 4.



View of soil removal activities
at Excavation 4 .



View of soil removal activities
at Excavation 5 .



View of equipment
staging area.



View of sand backfill at
Excavation 3 and Excavation
4.



View of topsoil at Excavation
3 and Excavation 4.



View of landscaping stone used
for restoration at Excavation 5.



View of straw mats used for
restoration on the east side
of the building.

ARCADIS

Appendix C

Removal Waste Transportation and
Disposal Documents



NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

83350

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number NA		b. Manifest Document Number 2009 08-003		c. Page 1 of 1	
d. Generator's Name and Location: United States Coast Guard 101 S Lakeshore Dr Ludington, MI 49431			e. Generator's Mailing Address: 214 S. Lakeshore Dr Ludington, MI 49431		
f. Phone: 216-402-6219			g. Phone:		
If owner of the generating facility differs from the generator, provide:					
h. Owner's Name:			i. Owner's Phone No.:		
j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	n. Total Quantity	o. Unit Wt/Vol
235y98744 ✓	12/31/2009	soil excavation waste	1 RT	18 cys	
GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions, I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.					
p. Generator Authorized Agent Name (Print) DEARDED FOLKIA			q. Signature <i>[Signature]</i>		r. Date 17 Aug 09

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address: K&D Inc 2982 Venture Dr Midland, MI 48640		
b. Phone:		
c. Driver Name (Print) GREG FAYLOR	d. Signature <i>[Signature]</i>	e. Date 4-18-09

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address: Manistee County Landfill 3890 Camp Rd Manistee, MI 49860		b. Phone:
c. US EPA Number	d. Discrepancy Indication Space:	
I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.		
e. Name of Authorized Agent (Print) Kim Johnson	f. Signature <i>[Signature]</i>	g. Date 8-18-09

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:		c. Responsible Agency Name and Address:	
b. Phone:		d. Phone:	
e. Special Handling Instructions and Additional Information:			
f. <input type="checkbox"/> Friable <input type="checkbox"/> Non-Friable <input type="checkbox"/> Both % Friable % Non-Friable			
OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.			
g. Operator's Name and Title (Print)		h. Signature	
i. Date		j. Date	
*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both			

57864 0

FAIRBANKS SCALES KC, MO 1-800-821-3522

WEIGHED ON A FAIRBANKS SCALE
RB-43

TICKET NUMBER 18001

CUSTOMER'S NAME _____

ADDRESS _____

COMMODITY _____

CARRIER _____

INBOUND 83260 lb
LOOP ID 16

INBOUND DATE 8-18-09 TIME 10:03AM
OUTBOUND DATE 8-18-09 TIME 10:47AM

83260 lb GROSS
57440 lb TARE
25820 lb NET

LOOP ID 16

DRIVER ON _____ OFF _____

SHIPPER _____

WEIGHER _____

FAIRBANKS SCALE CAT. 16288

Lynn,

10 pp



NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-f)

a. Generator's US EPA ID Number N/A		b. Manifest Document Number 2009 08-003		c. Page 1 of 1	
d. Generator's Name and Location: United States Coast Guard 101 S Lakeshore Dr Ludington, MI 49431 f. Phone: 216-902-6314			e. Generator's Mailing Address: 214 S. Lakeshore Dr Ludington, MI 49431 g. Phone:		
If owner of the generating facility differs from the generator, provide:					
h. Owner's Name:			i. Owner's Phone No.:		
j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	n. Total Quantity	o. Unit Wt/Vol
235y98744	12/31/2008	soil excavation waste	1 RT	18 cyd	
GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions, I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.					
p. Generator Authorized Agent Name (Print) DEARDED FORUMIA			q. Signature <i>[Signature]</i>		r. Date 17 AUG 09

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address: K&D Ind 2882 Venture Dr Midland, MI 48840 b. Phone:		
c. Driver Name (Print) GARY FAYLOR	d. Signature <i>[Signature]</i>	e. Date 8-18-09

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address: Manistee County Landfill 3890 Camp Rd Manistee, MI 49860 b. Phone:		c. US EPA Number	d. Discrepancy Indication Space:
I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.			
e. Name of Authorized Agent (Print) <i>[Signature]</i>	f. Signature <i>[Signature]</i>	g. Date 8-24-09	

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:		c. Responsible Agency Name and Address:	
b. Phone:		d. Phone:	
e. Special Handling Instructions and Additional Information:			
f. <input type="checkbox"/> Friable <input type="checkbox"/> Non-Friable <input type="checkbox"/> Both % Friable % Non-Friable			
OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable International and national governmental regulations.			
g. Operator's Name and Title (Print)		h. Signature	
		i. Date	
*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both			

57884 D

FAIRBANKS SCALES INC, MO 1-800-821-3322

WEIGHED ON A FAIRBANKS SCALE

RBS

TICKET NUMBER 18085

CUSTOMER'S NAME _____

ADDRESS _____

COMMODITY _____

CARRIER _____

INBOUND 90600 16
LOOP ID 16

INBOUND DATE 8-24-09 TIME 11:09AM

OUTBOUND DATE 8-24-09 TIME 12:04PM

90600 16 GROSS
57880 16 TARE
32720 16 NET

LOOP ID 16

DRIVER ON _____ OFF _____

SHIPPER _____

WEIGHER _____

FAIRBANKS SCALE CAT. 16288

If waste is asbestos waste, complete Sections I, II, III and IV
 If waste is **NOT** asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-c)

a. Generator's US EPA ID Number: NA

b. Manifest Document Number: 2009 08 - 001 c. Page 1 of 1

d. Generator's Name and Location:
1070 Lakeshore Dr
Ludington, MI 48431

e. Generator's Mailing Address:
214 S. Lakeshore Dr
Ludington, MI 48431

f. Phone: 216-402-6219

g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name:

i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers		n. Total Quantity	o. Unit Wt/Vol
			No.	Type		
23508744	12/31/2008	soil excavation waste	1	RT	18cyd	

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions, I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print): KEARL FORD q. Signature: [Signature] r. Date: 17 AUG 09

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
K&D Ind
2962 Venture Dr
Midland, MI 48640

b. Phone:

c. Driver Name (Print): Gene Taylor d. Signature: [Signature] e. Date: 9-18-09

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
Manistee County Landfill
3890 Camp Rd
Manistee, MI 48660

b. Phone:

c. US EPA Number

d. Discrepancy Indication Space:

I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print): William Selt f. Signature: [Signature] g. Date: 8-27-09

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print): h. Signature: i. Date:

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

2854 D

FAIRBANKS SCALES CO, MO 1-800-821-3322

RB-164

WEIGHED ON A FAIRBANKS SCALE

TICKET NUMBER 18138

CUSTOMER'S NAME _____

ADDRESS _____

COMMODITY _____

CARRIER _____

INBOUND 77960 lb
LOOP ID 83

INBOUND DATE 8-27-09 TIME 11:07AM

OUTBOUND DATE 8-27-09 TIME 11:51AM

77960 lb GROSS
57660 lb TARE
20300 lb NET

LOOP ID 83

DRIVER ON _____ OFF _____

SHIPPER _____

WEIGHER _____

FAIRBANKS SCALE CAT. 15288

ARCADIS

Appendix D

Standard Operating Procedures

	Standard Operating Procedure	
	Soil Sampling Equipment Decontamination Procedure	

1. Applicability

- 1.1 This Standard Operating Procedure (SOP) covers the decontamination of soil sampling equipment, including split-spoons, hand augers, scoops, or other devices used to collect soil samples. Because of the potential for the decontamination equipment to be a source of contamination, the equipment must be inspected prior to each use for signs of contamination or wear and replaced frequently to prevent cross-contamination of samples.
- 1.2 This SOP does not address health and safety, sample collection, or laboratory analysis.

2. Equipment/Supplies

- 2.1 Detergent (Alconox, Liquinox, TSP, etc.)
- 2.2 Steam distilled water or laboratory grade de-ionized water
- 2.3 Squirt bottle
- 2.4 Scrub brush
- 2.5 5-gallon plastic buckets (2)
- 2.6 Plastic sheeting
- 2.7 Paper towels
- 2.8 Field Log Book

3. Procedure

- 3.1 Prepare a detergent solution in one of the buckets according to the detergent manufacturer's directions.
- 3.2 Partially fill the second bucket with distilled water.
- 3.3 Remove soil or other material on the sampling device with tools or paper towels.

- 3.4 After the materials are removed from the sampling device, immerse the device in the detergent solution and scrub with the brush.
- 3.5 Remove the device from the detergent solution and allow to drain for a moment prior to immersing the device in the rinse water bucket.
- 3.6 Immerse the device in the rinse water bucket and agitate the device.
- 3.7 Remove the device from the rinse water and give the device a final rinse with copious amounts of water from the squirt bottle. Allow the water to drain from the device.
- 3.8 The device may be returned to use. If the device will be stored prior to its next use, cover the device with plastic and store at a location away from potential sources of contamination.

	Standard Operating Procedure	
	Soil Sampling for Chemical Analysis of Lead	

1. Applicability

- 1.1 This Standard Operating Procedure (SOP) covers the collection of soil samples for lead analysis in accordance with the appropriate USEPA sampling method.
- 1.2 This SOP does not address health and safety, equipment decontamination, field parameter measurements, sample preservation, chain-of-custody, or laboratory analysis.

2. Equipment/Supplies

- 2.1 Stainless steel knife or spatula
- 2.2 Stainless steel spoon
- 2.3 Stainless steel bowl
- 2.4 Sample containers
- 2.5 Plastic sheeting
- 2.6 Coolers
- 2.7 Ice
- 2.8 Chain-of-Custody form
- 2.9 Field Log Book
- 2.10 Soil Sampling and Decontamination Equipment
- 2.11 Site-Specific Quality Assurance Project Plan (QAPP)
- 2.12 Field Sampling Plan (FSP) or Removal Action Work Plan (RAWP)

3. Procedure

- 3.1 Soil samples may be obtained using a split-spoon, auger, trowel, scoop, or other appropriate device for the situation. Soil samples for lead may be collected as "grab" or "composite" samples depending on the project needs. The equipment must be cleaned before each use following the Soil Sampling Equipment Decontamination SOP or equivalent.
- 3.2 Prior to placing the soil into the container, remove larger media such as gravel and organic debris.
- 3.3 If the samples will be composite samples, mix the sample portions in a pre-cleaned stainless steel bowl with a pre-cleaned stainless steel spoon.

- 3.4 Place the sample into the sample container and fill it as completely as possible. Properly label and manage the sample following procedures described in the QAPP and FSP/RAWP.
- 3.5 Duplicate samples are prepared by alternately filling the container for the "confirmation sample" for lead analysis and then filling the container for the "duplicate sample" for that same parameter. Duplicate samples need to be included on the Chain-of-Custody form. Refer to the QAPP for duplicate sample requirements.
- 3.6 Matrix spike/matrix spike duplicates (MS/MSDs) are collected in the same manner as a duplicate sample. Check with the laboratory for the volume requirements for each parameter. MS/MSDs need to be included on the Chain-of-Custody form. Refer to the QAPP for MS/MSD requirements.
- 3.7 Equipment blanks are prepared by running distilled water over each piece of the sampling equipment after it has been decontaminated. Equipment blanks are to be collected for each piece of sampling equipment individually; check the QAPP for further details concerning equipment blank collection. Equipment blanks need to be included on the Chain-of-Custody form.
- 3.10 Samples should be placed into a cooler containing ice immediately after collection.
- 3.11 Ship the samples to the laboratory per project requirements following the Chain-of-Custody procedure described in the QAPP.

	Standard Operating Procedure	
	Surveying	

1. **Applicability**

A level survey of borings, monitoring wells, or various Site characteristics at each site is performed in order to: establish the elevation of the groundwater table; determine the direction of groundwater flow; define the subsurface stratigraphy; and to accurately locate the physical features at each site so that a base map can be created.

2. **Equipment/Supplies**

- Field book
- Pencils
- Transit or level
- Survey rod
- Tripod
- 200' tape to measure distances
- Spray paint, permanent marker
- Copies of available maps such as topographic, site, site vicinity
- Copies of previous sketches showing borings/wells location and number
- Safety cones or barricades

3. **Procedure**

3.1 **Equipment Handling**

- The level/transit is a sensitive, expensive instrument. Handle it accordingly. Keep it dry and clean as possible. Never carry the instrument in the back of the truck.
- Never leave the instrument on the tripod without securely attaching it.
- Make sure that the tripod is stable at all times.
- Always setup the tripod and instrument so that it is easily seen.
- Never leave a tripod and instrument unattended when surveying in an area with vehicular traffic. Place protective cones around the survey station.

- Keep an eye on the equipment at all times.
- Keep the survey rod free of dirt and grit.

3.2 Leveling the Instrument

- Center the level and screw it onto the tripod.
- Firmly plant the tripod legs.
- Use foot screw to level the instrument. The bubble must be within the setting circle in order for the instrument to be level.
- Rotate the level 360 degrees, checking to be sure that the bubble remains inside the circle at every point.

3.3 Focusing the Cross Hairs and Sighting

- To focus the cross hairs, look through the instrument and turn the ring around the eyepiece until the hairs come into focus.
- Relax your eye while looking through the eyepiece.
- Use a sun shade.

3.4 Rod

- Be careful when using a rod around overhead power and utility lines.
- The rod is graduated into hundredths of a foot. The bottom of each black line is an odd hundredth; the top of each black line is an even hundredth.
- When surveying to the rod, the rod should be moved forward and back to determine the lowest, and most accurate, reading.

3.5 Stadia Surveys

- Readings should be taken at the intersection of the vertical cross hair with the three horizontal cross hairs (a level survey requires reading only the center cross hair).
- Distance (D) calculation:

$$D = (\text{High Stadia} - \text{Low Stadia}) \times 100$$

ex:

High Stadia = 8.87	$D = (8.87 - 8.29) \times 100$
Low Stadia = 8.2	$D = 58.0$

- Check the accuracy of your readings as you survey. An acceptable error is 1/100' difference between calculations per siting.
- Check Readings: high - mid = mid - low

3.6 Bench Marks

- Clearly note the location and type of the bench mark used for each survey. The location should be marked permanently in the field so that it may be reused.
- If an existing bench mark with a known elevation is within a reasonable distance of the site, the surveyors should attempt to use it as the bench mark for the survey. Possible existing bench marks are sewer manhole rims, storm drains, USGS (from topo map).
- If there is no known bench mark in the area, a bench mark must be created arbitrarily.
- Use the following guidelines for establishing an arbitrary bench mark:
 - a) use permanent physical features such as the corner of a pump island, cement floor slab, manhole or sewer rim.
 - b) assign an elevation to the bench mark; if the nearest 10-foot contour is known, use it as the BM elevation; if the contour elevation is not known assign an arbitrary elevation.
 - c) clearly note the location and elevation of the BM in the field and on all site plans.
 - d) Do not use monitoring or recovery wells as bench marks.

3.7 Level Surveys

- When surveying wells, make certain to choose a survey point that can be used when gauging the well; if the top of the PVC casing is greater than 6 inches below the ground surface do not use it as the survey point, instead use the lip or rim of the protective casing. Clearly note the survey point of each well in the survey notes.

- Permanently mark the survey point with paint or permanent marker.
- Place the rod on the survey point and hold it vertical; move it backwards and forwards to determine the most accurate reading.
- Calculate the elevation from the middle cross hair reading.
- Limit the number of times the instrument must be moved.
- After completing level readings at each set up, shoot back to two or more wells to close the level run.
- In a multiple-station survey, always shoot at least two known points for each station.
- Calculate elevations before moving instrument to determine if there are any irregularities or errors.

3.8 Turning Points

- A Turning Point (TP) is used when all of the survey points cannot be seen from one instrument position and the instrument must be moved.
- The TP essentially establishes a new bench mark from which a new height of instrument is calculated.
- A TP can be a permanent structure, a PK, the original BM, or a well. (A PK is a surveyor's nail driven into the ground/asphalt to create a hub for the rod to rest upon).
- Complete the following steps to create a TP:
 - a) take a FS (foresight) on the TP and record the measurement under the FS column in the field book;
 - b) the FS is subtracted from the HI (height of instrument) for the current instrument location to determine the elevation of the TP;
 - c) the instrument is then moved to a new location and leveled;
 - d) a BS (backsight) reading is taken to the TP and entered in the BS column in the field book;
 - e) the BS is added to the TP to determine the new HI elevation;
 - f) note: the TP entry in the survey data in the field book will always have 4 entries: BS, FS, HI, and elevation.

3.9 Taping Locations

- Use a tape to verify distances that were surveyed with the instrument.
- Obtain three measurements for each location.
- Pull the tape tightly between points being measured.
- Measure dimensions of buildings on site to confirm base maps.

3.10 General

- When surveying wells, choose a survey point that can be used when gauging the well.
- If the top of the well casing is greater than 6 inches below the ground surface, DO NOT use the well casing as the survey point; instead, use the lip or rim of the protective casing as the survey point.
- Obtain the following for each monitoring well survey location:
 - a) the elevation of the top of the well casing (T.O.C.);
 - b) the elevation of the lip or rim of the protective casing (T.O.R.);
 - c) the elevation of the ground surface adjacent to the well (T.O.G.).
- Where there is a significant topographic change across a site, additional survey information will be required in order to document the ground surface elevation differences; this information is critical when drawing cross-sections and in planning trenching and infiltration gallery installations.

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the in situ and intrusive analysis of the 26 analytes listed below for soil and sediment samples. Some common elements are not listed in this method because they are considered "light" elements that cannot be detected by field portable x-ray fluorescence (FPXRF). These light elements are: lithium, beryllium, sodium, magnesium, aluminum, silicon, and phosphorus. Most of the analytes listed below are of environmental concern, while a few others have interference effects or change the elemental composition of the matrix, affecting quantitation of the analytes of interest. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF. The following RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Antimony (Sb)	7440-36-0
Arsenic (As)	7440-38-0
Barium (Ba)	7440-39-3
Cadmium (Cd)	7440-43-9
Chromium (Cr)	7440-47-3
Cobalt (Co)	7440-48-4
Copper (Cu)	7440-50-8
Lead (Pb)	7439-92-1
Mercury (Hg)	7439-97-6
Nickel (Ni)	7440-02-0
Selenium (Se)	7782-49-2
Silver (Ag)	7440-22-4
Thallium (Tl)	7440-28-0
Tin (Sn)	7440-31-5

Analytes	CAS Registry No.
Vanadium (V)	7440-62-2
Zinc (Zn)	7440-66-6

In addition, the following non-RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Calcium (Ca)	7440-70-2
Iron (Fe)	7439-89-6
Manganese (Mn)	7439-96-5
Molybdenum (Mo)	7439-93-7
Potassium (K)	7440-09-7
Rubidium (Rb)	7440-17-7
Strontium (Sr)	7440-24-6
Thorium (Th)	7440-29-1
Titanium (Ti)	7440-32-6
Zirconium (Zr)	7440-67-7

1.2 This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnace atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)). This method's main strength is that it is a rapid field screening procedure. The method's lower limits of detection are typically above the toxicity characteristic regulatory level for most RCRA analytes. However, when the obtainable values for precision, accuracy, and laboratory-established sensitivity of this method meet project-specific data quality objectives (DQOs), FPXRF is a fast, powerful, cost effective technology for site characterization.

1.3 The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 1. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement spectral interferences using long (100 -600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, since they will vary depending on the sample matrix, which instrument is used, and operating conditions. A discussion of performance-based sensitivity is presented in Sec. 9.6.

1.4 Analysts should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use and operation of an XRF instrument. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 The FPXRF technologies described in this method use either sealed radioisotope sources or x-ray tubes to irradiate samples with x-rays. When a sample is irradiated with x-rays, the source x-rays may undergo either scattering or absorption by sample atoms. This latter process is known as the photoelectric effect. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. Electrons in outer shells have higher energy states than inner shell electrons, and the outer shell electrons give off energy as they cascade down into the inner shell vacancies. This rearrangement of electrons results in emission of x-rays characteristic of the given atom. The emission of x-rays, in this manner, is termed x-ray fluorescence.

Three electron shells are generally involved in emission of x-rays during FPXRF analysis of environmental samples. The three electron shells include the K, L, and M shells. A typical emission pattern, also called an emission spectrum, for a given metal has multiple intensity peaks generated from the emission of K, L, or M shell electrons. The most commonly measured x-ray emissions are from the K and L shells; only metals with an atomic number greater than 57 have measurable M shell emissions.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α), beta (β), or gamma (γ) etc., which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a K_{α} line is produced by a vacancy in the K shell filled by an L shell electron, whereas a K_{β} line is produced by a vacancy in the K shell filled by an M shell electron. The K_{α} transition is on average 6 to 7 times more probable than the K_{β} transition; therefore, the K_{α} line is approximately 7 times more intense than the K_{β} line for a given element, making the K_{α} line the choice for quantitation purposes.

The K lines for a given element are the most energetic lines and are the preferred lines for analysis. For a given atom, the x-rays emitted from L transitions are always less energetic than those emitted from K transitions. Unlike the K lines, the main L emission lines (L_{α} and L_{β}) for an element are of nearly equal intensity. The choice of one or the other depends on what interfering element lines might be present. The L emission lines are useful for analyses involving elements of atomic number (Z) 58 (cerium) through 92 (uranium).

An x-ray source can excite characteristic x-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element, that is, the K absorption edge, L absorption edge, or M absorption edge energy. The absorption edge energy is somewhat greater than the corresponding line energy. Actually, the K absorption edge energy is approximately the sum of the K, L, and M line energies of the particular element, and the L absorption edge energy is approximately the sum of the L and M line energies. FPXRF is more sensitive to an element with an absorption edge energy close to but less than

the excitation energy of the source. For example, when using a cadmium-109 source, which has an excitation energy of 22.1 kiloelectron volts (keV), FPXRF would exhibit better sensitivity for zirconium which has a K line energy of 15.77 keV than to chromium, which has a K line energy of 5.41 keV.

2.2 Under this method, inorganic analytes of interest are identified and quantitated using a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic x-ray emissions from elements in a sample. Up to three sources may be used to irradiate a sample. Each source emits a specific set of primary x-rays that excite a corresponding range of elements in a sample. When more than one source can excite the element of interest, the source is selected according to its excitation efficiency for the element of interest.

For measurement, the sample is positioned in front of the probe window. This can be done in two manners using FPXRF instruments, specifically, *in situ* or *intrusive*. If operated in the *in situ* mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the *intrusive* mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. The sample cup is then placed on top of the window inside a protective cover for analysis.

Sample analysis is then initiated by exposing the sample to primary radiation from the source. Fluorescent and backscattered x-rays from the sample enter through the detector window and are converted into electric pulses in the detector. The detector in FPXRF instruments is usually either a solid-state detector or a gas-filled proportional counter. Within the detector, energies of the characteristic x-rays are converted into a train of electric pulses, the amplitudes of which are linearly proportional to the energy of the x-rays. An electronic multichannel analyzer (MCA) measures the pulse amplitudes, which is the basis of qualitative x-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis. Most FPXRF instruments are menu-driven from software built into the units or from personal computers (PC).

The measurement time of each source is user-selectable. Shorter source measurement times (30 seconds) are generally used for initial screening and hot spot delineation, and longer measurement times (up to 300 seconds) are typically used to meet higher precision and accuracy requirements.

FPXRF instruments can be calibrated using the following methods: internally using fundamental parameters determined by the manufacturer, empirically based on site-specific calibration standards (SSCS), or based on Compton peak ratios. The Compton peak is produced by backscattering of the source radiation. Some FPXRF instruments can be calibrated using multiple methods.

3.0 DEFINITIONS

- 3.1 FPXRF -- Field portable x-ray fluorescence.
- 3.2 MCA -- Multichannel analyzer for measuring pulse amplitude.
- 3.3 SSCS -- Site-specific calibration standards.
- 3.4 FP -- Fundamental parameter.
- 3.5 ROI -- Region of interest.

3.6 SRM -- Standard reference material; a standard containing certified amounts of metals in soil or sediment.

3.7 eV -- Electron volt; a unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of one volt.

3.8 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for other definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 The total method error for FPXRF analysis is defined as the square root of the sum of squares of both instrument precision and user- or application-related error. Generally, instrument precision is the least significant source of error in FPXRF analysis. User- or application-related error is generally more significant and varies with each site and method used. Some sources of interference can be minimized or controlled by the instrument operator, but others cannot. Common sources of user- or application-related error are discussed below.

4.2 Physical matrix effects result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, if any analyte exists in the form of very fine particles in a coarser-grained matrix, the analyte's concentration measured by the FPXRF will vary depending on how fine particles are distributed within the coarser-grained matrix. If the fine particles "settle" to the bottom of the sample cup (i.e., against the cup window), the analyte concentration measurement will be higher than if the fine particles are not mixed in well and stay on top of the coarser-grained particles in the sample cup. One way to reduce such error is to grind and sieve all soil samples to a uniform particle size thus reducing sample-to-sample particle size variability. Homogeneity is always a concern when dealing with soil samples. Every effort should be made to thoroughly mix and homogenize soil samples before analysis. Field studies have shown heterogeneity of the sample generally has the largest impact on comparability with confirmatory samples.

4.3 Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven. Microwave drying is not recommended because field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory analysis and because metal fragments in the sample can cause arcing to occur in a microwave.

4.4 Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

4.5 Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Both effects are common in soils contaminated with heavy metals. As examples of absorption and enhancement effects; iron (Fe) tends to absorb copper (Cu) x-rays, reducing the intensity of the Cu measured by the detector, while chromium (Cr) will be enhanced at the expense of Fe because the absorption edge of Cr is slightly lower in energy than the fluorescent peak of iron. The effects can be corrected mathematically through the use of fundamental parameter (FP) coefficients. The effects also can be compensated for using SSCS, which contain all the elements present on site that can interfere with one another.

4.6 When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum. The degree to which a detector can resolve the two different peaks depends on the energy resolution of the detector. If the energy difference between the two peaks in electron volts is less than the resolution of the detector in electron volts, then the detector will not be able to fully resolve the peaks.

The most common spectrum overlaps involve the K_{β} line of element Z-1 with the K_{α} line of element Z. This is called the K_{α}/K_{β} interference. Because the $K_{\alpha}:K_{\beta}$ intensity ratio for a given element usually is about 7:1, the interfering element, Z-1, must be present at large concentrations to cause a problem. Two examples of this type of spectral interference involve the presence of large concentrations of vanadium (V) when attempting to measure Cr or the presence of large concentrations of Fe when attempting to measure cobalt (Co). The V K_{α} and K_{β} energies are 4.95 and 5.43 keV, respectively, and the Cr K_{α} energy is 5.41 keV. The Fe K_{α} and K_{β} energies are 6.40 and 7.06 keV, respectively, and the Co K_{α} energy is 6.92 keV. The difference between the V K_{β} and Cr K_{α} energies is 20 eV, and the difference between the Fe K_{β} and the Co K_{α} energies is 140 eV. The resolution of the highest-resolution detectors in FPXRF instruments is 170 eV. Therefore, large amounts of V and Fe will interfere with quantitation of Cr or Co, respectively. The presence of Fe is a frequent problem because it is often found in soils at tens of thousands of parts per million (ppm).

4.7 Other interferences can arise from K/L, K/M, and L/M line overlaps, although these overlaps are less common. Examples of such overlap involve arsenic (As) K_{α} /lead (Pb) L_{α} and sulfur (S) K_{α} /Pb M_{α} . In the As/Pb case, Pb can be measured from the Pb L_{β} line, and As can be measured from either the As K_{α} or the As K_{β} line; in this way the interference can be corrected. If the As K_{β} line is used, sensitivity will be decreased by a factor of two to five times because it is a less intense line than the As K_{α} line. If the As K_{α} line is used in the presence of Pb, mathematical corrections within the instrument software can be used to subtract out the Pb interference. However, because of the limits of mathematical corrections, As concentrations cannot be efficiently calculated for samples with Pb:As ratios of 10:1 or more. This high ratio of Pb to As may result in reporting of a "nondetect" or a "less than" value (e.g., <300 ppm) for As, regardless of the actual concentration present.

No instrument can fully compensate for this interference. It is important for an operator to understand this limitation of FPXRF instruments and consult with the manufacturer of the FPXRF instrument to evaluate options to minimize this limitation. The operator's decision will be based on action levels for metals in soil established for the site, matrix effects, capabilities of the instrument, data quality objectives, and the ratio of lead to arsenic known to be present at the site. If a site is encountered that contains lead at concentrations greater than ten times the concentration of arsenic it is advisable that all critical soil samples be sent off site for confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnace atomic absorption spectrometry (GFAA), inductively coupled plasma-

atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)).

4.8 If SSCS are used to calibrate an FPXRF instrument, the samples collected must be representative of the site under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentrations of the contaminants of concern at a given time and location. Analytical results for representative samples reflect variations in the presence and concentration ranges of contaminants throughout a site. Variables affecting sample representativeness include differences in soil type, contaminant concentration variability, sample collection and preparation variability, and analytical variability, all of which should be minimized as much as possible.

4.9 Soil physical and chemical effects may be corrected using SSCS that have been analyzed by inductively coupled plasma (ICP) or atomic absorption (AA) methods. However, a major source of error can be introduced if these samples are not representative of the site or if the analytical error is large. Another concern is the type of digestion procedure used to prepare the soil samples for the reference analysis. Analytical results for the confirmatory method will vary depending on whether a partial digestion procedure, such as Method 3050, or a total digestion procedure, such as Method 3052, is used. It is known that depending on the nature of the soil or sediment, Method 3050 will achieve differing extraction efficiencies for different analytes of interest. The confirmatory method should meet the project-specific data quality objectives (DQOs).

XRF measures the total concentration of an element; therefore, to achieve the greatest comparability of this method with the reference method (reduced bias), a total digestion procedure should be used for sample preparation. However, in the study used to generate the performance data for this method (see Table 8), the confirmatory method used was Method 3050, and the FPXRF data compared very well with regression correlation coefficients (r often exceeding 0.95, except for barium and chromium). The critical factor is that the digestion procedure and analytical reference method used should meet the DQOs of the project and match the method used for confirmation analysis.

4.10 Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most FPXRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the FPXRF instrument has an automatic gain control function, the operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration. The performance of an energy calibration check to assess drift is a quality control measure discussed in Sec. 9.2.

If the operator is instructed by the manufacturer to manually conduct a gain check because of increasing or decreasing ambient temperature, it is standard to perform a gain check after every 10 to 20 sample measurements or once an hour whichever is more frequent. It is also suggested that a gain check be performed if the temperature fluctuates more than 10° F. The operator should follow the manufacturer's recommendations for gain check frequency.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The user is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

NOTE: No MSDS applies directly to the radiation-producing instrument because that is covered under the Nuclear Regulatory Commission (NRC) or applicable state regulations.

5.2 Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Radiation safety for each specific instrument can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local state and national regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. There should be a person appointed within the organization that is solely responsible for properly instructing all personnel, maintaining inspection records, and monitoring x-ray equipment at regular intervals.

Licenses for radioactive materials are of two types, specifically: (1) a general license which is usually initiated by the manufacturer for receiving, acquiring, owning, possessing, using, and transferring radioactive material incorporated in a device or equipment, and (2) a specific license which is issued to named persons for the operation of radioactive instruments as required by local, state, or federal agencies. A copy of the radioactive material license (for specific licenses only) and leak tests should be present with the instrument at all times and available to local and national authorities upon request.

X-ray tubes do not require radioactive material licenses or leak tests, but do require approvals and licenses which vary from state to state. In addition, fail-safe x-ray warning lights should be illuminated whenever an x-ray tube is energized. Provisions listed above concerning radiation safety regulations, shielding, training, and responsible personnel apply to x-ray tubes just as to radioactive sources. In addition, a log of the times and operating conditions should be kept whenever an x-ray tube is energized. An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply, however, if the tube is properly positioned within the instrument, this is only a negligible risk. Any instrument (x-ray tube or radioisotope based) is capable of delivering an electric shock from the basic circuitry when the system is inappropriately opened.

5.3 Radiation monitoring equipment should be used with the handling and operation of the instrument. The operator and the surrounding environment should be monitored continually for analyst exposure to radiation. Thermal luminescent detectors (TLD) in the form of badges and rings are used to monitor operator radiation exposure. The TLDs or badges should be worn in the area of maximum exposure. The maximum permissible whole-body dose from occupational exposure is 5 Roentgen Equivalent Man (REM) per year. Possible exposure pathways for radiation to enter the body are ingestion, inhaling, and absorption. The best precaution to prevent radiation exposure is distance and shielding.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for

use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

6.1 FPXRF spectrometer -- An FPXRF spectrometer consists of four major components: (1) a source that provides x-rays; (2) a sample presentation device; (3) a detector that converts x-ray-generated photons emitted from the sample into measurable electronic signals; and (4) a data processing unit that contains an emission or fluorescence energy analyzer, such as an MCA, that processes the signals into an x-ray energy spectrum from which elemental concentrations in the sample may be calculated, and a data display and storage system. These components and additional, optional items, are discussed below.

6.1.1 Excitation sources -- FPXRF instruments use either a sealed radioisotope source or an x-ray tube to provide the excitation source. Many FPXRF instruments use sealed radioisotope sources to produce x-rays in order to irradiate samples. The FPXRF instrument may contain between one and three radioisotope sources. Common radioisotope sources used for analysis for metals in soils are iron Fe-55 (^{55}Fe), cadmium Cd-109 (^{109}Cd), americium Am-241 (^{241}Am), and curium Cm-244 (^{244}Cm). These sources may be contained in a probe along with a window and the detector; the probe may be connected to a data reduction and handling system by means of a flexible cable. Alternatively, the sources, window, and detector may be included in the same unit as the data reduction and handling system.

The relative strength of the radioisotope sources is measured in units of millicuries (mCi). All other components of the FPXRF system being equal, the stronger the source, the greater the sensitivity and precision of a given instrument. Radioisotope sources undergo constant decay. In fact, it is this decay process that emits the primary x-rays used to excite samples for FPXRF analysis. The decay of radioisotopes is measured in "half-lives." The half-life of a radioisotope is defined as the length of time required to reduce the radioisotopes strength or activity by half. Developers of FPXRF technologies recommend source replacement at regular intervals based on the source's half-life. This is due to the ever increasing time required for the analysis rather than a decrease in instrument performance. The characteristic x-rays emitted from each of the different sources have energies capable of exciting a certain range of analytes in a sample. Table 2 summarizes the characteristics of four common radioisotope sources.

X-ray tubes have higher radiation output, no intrinsic lifetime limit, produce constant output over their lifetime, and do not have the disposal problems of radioactive sources but are just now appearing in FPXRF instruments. An electrically-excited x-ray tube operates by bombarding an anode with electrons accelerated by a high voltage. The electrons gain an energy in electron volts equal to the accelerating voltage and can excite atomic transitions in the anode, which then produces characteristic x-rays. These characteristic x-rays are emitted through a window which contains the vacuum necessary for the electron acceleration. An important difference between x-ray tubes and radioactive sources is that the electrons which bombard the anode also produce a continuum of x-rays across a broad range of energies in addition to the characteristic x-rays. This continuum is weak compared to the characteristic x-rays but can provide substantial excitation since it covers a broad energy range. It has the undesired property of producing background in the spectrum near the analyte x-ray lines when it is scattered by the sample. For this reason a filter is often used between the x-ray tube and the sample to suppress the continuum radiation while passing the characteristic x-rays from the anode. This filter is sometimes incorporated into the window of the x-ray tube. The choice of

accelerating voltage is governed both by the anode material, since the electrons must have sufficient energy to excite the anode, which requires a voltage greater than the absorption edge of the anode material and by the instrument's ability to cool the x-ray tube. The anode is most efficiently excited by voltages 2 to 2.5 times the edge energy (most x-rays per unit power to the tube), although voltages as low as 1.5 times the absorption edge energy will work. The characteristic x-rays emitted by the anode are capable of exciting a range of elements in the sample just as with a radioactive source. Table 3 gives the recommended operating voltages and the sample elements excited for some common anodes.

6.1.2 Sample presentation device -- FPXRF instruments can be operated in two modes: in situ and intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. For FPXRF instruments operated in the intrusive mode, the probe may be rotated so that the window faces either upward or downward. A protective sample cover is placed over the window, and the sample cup is placed on top of the window inside the protective sample cover for analysis.

6.1.3 Detectors -- The detectors in the FPXRF instruments can be either solid-state detectors or gas-filled, proportional counter detectors. Common solid-state detectors include mercuric iodide (HgI_2), silicon pin diode and lithium-drifted silicon $\text{Si}(\text{Li})$. The HgI_2 detector is operated at a moderately subambient temperature controlled by a low power thermoelectric cooler. The silicon pin diode detector also is cooled via the thermoelectric Peltier effect. The $\text{Si}(\text{Li})$ detector must be cooled to at least -90°C either with liquid nitrogen or by thermoelectric cooling via the Peltier effect. Instruments with a $\text{Si}(\text{Li})$ detector have an internal liquid nitrogen dewar with a capacity of 0.5 to 1.0 L. Proportional counter detectors are rugged and lightweight, which are important features of a field portable detector. However, the resolution of a proportional counter detector is not as good as that of a solid-state detector. The energy resolution of a detector for characteristic x-rays is usually expressed in terms of full width at half-maximum (FWHM) height of the manganese K_α peak at 5.89 keV. The typical resolutions of the above mentioned detectors are as follows: HgI_2 -270 eV; silicon pin diode-250 eV; $\text{Si}(\text{Li})$ -170 eV; and gas-filled, proportional counter-750 eV.

During operation of a solid-state detector, an x-ray photon strikes a biased, solid-state crystal and loses energy in the crystal by producing electron-hole pairs. The electric charge produced is collected and provides a current pulse that is directly proportional to the energy of the x-ray photon absorbed by the crystal of the detector. A gas-filled, proportional counter detector is an ionization chamber filled with a mixture of noble and other gases. An x-ray photon entering the chamber ionizes the gas atoms. The electric charge produced is collected and provides an electric signal that is directly proportional to the energy of the x-ray photon absorbed by the gas in the detector.

6.1.4 Data processing units -- The key component in the data processing unit of an FPXRF instrument is the MCA. The MCA receives pulses from the detector and sorts them by their amplitudes (energy level). The MCA counts pulses per second to determine the height of the peak in a spectrum, which is indicative of the target analyte's concentration. The spectrum of element peaks are built on the MCA. The MCAs in FPXRF instruments have from 256 to 2,048 channels. The concentrations of target analytes are usually shown in ppm on a liquid crystal display (LCD) in the instrument. FPXRF instruments can store both spectra and from 3,000 to 5,000 sets of numerical analytical results. Most FPXRF instruments are menu-driven from software built into the

units or from PCs. Once the data-storage memory of an FPXRF unit is full or at any other time, data can be downloaded by means of an RS-232 port and cable to a PC.

6.2 Spare battery and battery charger.

6.3 Polyethylene sample cups -- 31 to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

6.4 X-ray window film -- Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 µm thick.

6.5 Mortar and pestle -- Glass, agate, or aluminum oxide; for grinding soil and sediment samples.

6.6 Containers -- Glass or plastic to store samples.

6.7 Sieves -- 60-mesh (0.25 mm), stainless-steel, Nylon, or equivalent for preparing soil and sediment samples.

6.8 Trowels -- For smoothing soil surfaces and collecting soil samples.

6.9 Plastic bags -- Used for collection and homogenization of soil samples.

6.10 Drying oven -- Standard convection or toaster oven, for soil and sediment samples that require drying.

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Pure element standards -- Each pure, single-element standard is intended to produce strong characteristic x-ray peaks of the element of interest only. Other elements present must not contribute to the fluorescence spectrum. A set of pure element standards for commonly sought analytes is supplied by the instrument manufacturer, if designated for the instrument; not all instruments require the pure element standards. The standards are used to set the region of interest (ROI) for each element. They also can be used as energy calibration and resolution check samples.

7.3 Site-specific calibration standards -- Instruments that employ fundamental parameters (FP) or similar mathematical models in minimizing matrix effects may not require SSCS. If the FP calibration model is to be optimized or if empirical calibration is necessary, then SSCSs must be collected, prepared, and analyzed.

7.3.1 The SSCS must be representative of the matrix to be analyzed by FPXRF. These samples must be well homogenized. A minimum of 10 samples spanning the concentration ranges of the analytes of interest and of the interfering elements must be obtained from the site. A sample size of 4 to 8 ounces is recommended, and standard glass sampling jars should be used.

7.3.2 Each sample should be oven-dried for 2 to 4 hr at a temperature of less than 150 °C. If mercury is to be analyzed, a separate sample portion should be dried at ambient temperature as heating may volatilize the mercury. When the sample is dry, all large, organic debris and nonrepresentative material, such as twigs, leaves, roots, insects, asphalt, and rock should be removed. The sample should be homogenized (see Sec. 7.3.3) and then a representative portion ground with a mortar and pestle or other mechanical means, prior to passing through a 60-mesh sieve. Only the coarse rock fraction should remain on the screen.

7.3.3 The sample should be homogenized by using a riffle splitter or by placing 150 to 200 g of the dried, sieved sample on a piece of kraft or butcher paper about 1.5 by 1.5 feet in size. Each corner of the paper should be lifted alternately, rolling the soil over on itself and toward the opposite corner. The soil should be rolled on itself 20 times. Approximately 5 g of the sample should then be removed and placed in a sample cup for FPXRF analysis. The rest of the prepared sample should be sent off site for ICP or AA analysis. The method use for confirmatory analysis should meet the data quality objectives of the project.

7.4 Blank samples -- The blank samples should be from a "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limit of detection. These samples are used to monitor for cross-contamination and laboratory-induced contaminants or interferences.

7.5 Standard reference materials -- Standard reference materials (SRMs) are standards containing certified amounts of metals in soil or sediment. These standards are used for accuracy and performance checks of FPXRF analyses. SRMs can be obtained from the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian National Research Council, and the national bureau of standards in foreign nations. Pertinent NIST SRMs for FPXRF analysis include 2704, Buffalo River Sediment; 2709, San Joaquin Soil; and 2710 and 2711, Montana Soil. These SRMs contain soil or sediment from actual sites that has been analyzed using independent inorganic analytical methods by many different laboratories. When these SRMs are unavailable, alternate standards may be used (e.g., NIST 2702).

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Sample handling and preservation procedures used in FPXRF analyses should follow the guidelines in Chapter Three, "Inorganic Analytes."

9.0 QUALITY CONTROL

9.1 Follow the manufacturer's instructions for the quality control procedures specific to use of the testing product. Refer to Chapter One for additional guidance on quality assurance (QA) and quality control (QC) protocols. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results.

9.2 Energy calibration check -- To determine whether an FPXRF instrument is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting,

which would indicate drift within the instrument. As discussed in Sec. 4.10, this check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (more than 10 °F).

9.2.1 The energy calibration check should be run at a frequency consistent with manufacturer's recommendations. Generally, this would be at the beginning of each working day, after the batteries are changed or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis. A pure element such as iron, manganese, copper, or lead is often used for the energy calibration check. A manufacturer-recommended count time per source should be used for the check.

9.2.2 The instrument manufacturer's manual specifies the channel or kiloelectron volt level at which a pure element peak should appear and the expected intensity of the peak. The intensity and channel number of the pure element as measured using the source should be checked and compared to the manufacturer's recommendation. If the energy calibration check does not meet the manufacturer's criteria, then the pure element sample should be repositioned and reanalyzed. If the criteria are still not met, then an energy calibration should be performed as described in the manufacturer's manual. With some FPXRF instruments, once a spectrum is acquired from the energy calibration check, the peak can be optimized and realigned to the manufacturer's specifications using their software.

9.3 Blank samples -- Two types of blank samples should be analyzed for FPXRF analysis, specifically, instrument blanks and method blanks.

9.3.1 An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window. The instrument blank can be silicon dioxide, a polytetrafluoroethylene (PTFE) block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project. A manufacturer-recommended count time per source should be used for the blank analysis. No element concentrations above the established lower limit of detection should be found in the instrument blank. If concentrations exceed these limits, then the probe window and the check sample should be checked for contamination. If contamination is not a problem, then the instrument must be "zeroed" by following the manufacturer's instructions.

9.3.2 A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. If the method blank does not contain the target analyte at a level that interferes with the project-specific data quality objectives then the method blank would be considered acceptable. In the absence of project-specific data quality objectives, if the blank is less than the lowest level of detection or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the method blank would be considered acceptable. If the method blank cannot be considered acceptable, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.4 Calibration verification checks -- A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check sample should be a well characterized soil sample from the site that is representative of site samples in terms of particle size and degree of homogeneity and that contains contaminants at concentrations near the action levels. If a site-specific sample is not available, then an NIST or other SRM that contains the analytes of interest can be used to verify the accuracy of the instrument. The measured value for each target analyte should be within ± 20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be recalibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.5 Precision measurements -- The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. Determining method precision for analytes at concentrations near the site action levels can be extremely important if the FPXRF results are to be used in an enforcement action; therefore, selection of at least one sample with target analyte concentrations at or near the site action levels or levels of concern is recommended. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent. If both in situ and intrusive analytical techniques are used during the course of one day, it is recommended that separate precision calculations be performed for each analysis type.

The equation for calculating RSD is as follows:

$$\text{RSD} = (\text{SD} / \text{Mean Concentration}) \times 100$$

where:

RSD	=	Relative standard deviation for the precision measurement for the analyte
SD	=	Standard deviation of the concentration for the analyte
Mean concentration	=	Mean concentration for the analyte

The precision or reproducibility of a measurement will improve with increasing count time, however, increasing the count time by a factor of 4 will provide only 2 times better precision, so there is a point of diminishing return. Increasing the count time also improves the sensitivity, but decreases sample throughput.

9.6 The lower limits of detection should be established from actual measured performance based on spike recoveries in the matrix of concern or from acceptable method performance on a certified reference material of the appropriate matrix and within the appropriate calibration range for the application. This is considered the best estimate of the true method sensitivity as opposed to a statistical determination based on the standard deviation of

replicate analyses of a low-concentration sample. While the statistical approach demonstrates the potential data variability for a given sample matrix at one point in time, it does not represent what can be detected or most importantly the lowest concentration that can be calibrated. For this reason the sensitivity should be established as the lowest point of detection based on acceptable target analyte recovery in the desired sample matrix.

9.7 Confirmatory samples -- The comparability of the FPXRF analysis is determined by submitting FPXRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 FPXRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on project-specific data quality objectives. The confirmatory analyses can also be used to verify the quality of the FPXRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the FPXRF. They should also include samples with analyte concentrations at or near the site action levels. The results of the confirmatory analysis and FPXRF analyses should be evaluated with a least squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance which is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r is 0.9 or greater and inferential statistics indicate the FPXRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Instrument calibration -- Instrument calibration procedures vary among FPXRF instruments. Users of this method should follow the calibration procedures outlined in the operator's manual for each specific FPXRF instrument. Generally, however, three types of calibration procedures exist for FPXRF instruments, namely: FP calibration, empirical calibration, and the Compton peak ratio or normalization method. These three types of calibration are discussed below.

10.2 Fundamental parameters calibration -- FP calibration procedures are extremely variable. An FP calibration provides the analyst with a "standardless" calibration. The advantages of FP calibrations over empirical calibrations include the following:

- No previously collected site-specific samples are necessary, although site-specific samples with confirmed and validated analytical results for all elements present could be used.
- Cost is reduced because fewer confirmatory laboratory results or calibration standards are necessary.

However, the analyst should be aware of the limitations imposed on FP calibration by particle size and matrix effects. These limitations can be minimized by adhering to the preparation procedure described in Sec. 7.3. The two FP calibration processes discussed below are based on an effective energy FP routine and a back scatter with FP (BFP) routine. Each FPXRF FP calibration process is based on a different iterative algorithmic method. The calibration procedure for each routine is explained in detail in the manufacturer's user manual for each FPXRF instrument; in addition, training courses are offered for each instrument.

10.2.1 Effective energy FP calibration -- The effective energy FP calibration is performed by the manufacturer before an instrument is sent to the analyst. Although SSCS can be used, the calibration relies on pure element standards or SRMs such as those obtained from NIST for the FP calibration. The effective energy routine relies on the spectrometer response to pure elements and FP iterative algorithms to compensate for various matrix effects.

Alpha coefficients are calculated using a variation of the Sherman equation, which calculates theoretical intensities from the measurement of pure element samples. These coefficients indicate the quantitative effect of each matrix element on an analyte's measured x-ray intensity. Next, the Lachance Traill algorithm is solved as a set of simultaneous equations based on the theoretical intensities. The alpha coefficients are then downloaded into the specific instrument.

The working effective energy FP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of sampling. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. A manufacturer-recommended count time per source should be used for the calibration check. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A percent difference (%D) is then calculated for each target analyte. The %D should be within ± 20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. The SRM or SSCS is reanalyzed until the %D falls within ± 20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

The equation to calibrate %D is as follows:

$$\%D = ((C_s - C_k) / C_k) \times 100$$

where:

%D = Percent difference

C_k = Certified concentration of standard sample

C_s = Measured concentration of standard sample

10.2.2 BFP calibration -- BFP calibration relies on the ability of the liquid nitrogen-cooled, Si(Li) solid-state detector to separate the coherent (Compton) and incoherent (Rayleigh) backscatter peaks of primary radiation. These peak intensities are known to be a function of sample composition, and the ratio of the Compton to Rayleigh peak is a function of the mass absorption of the sample. The calibration procedure is explained in detail in the instrument manufacturer's manual. Following is a general description of the BFP calibration procedure.

The concentrations of all detected and quantified elements are entered into the computer software system. Certified element results for an NIST SRM or confirmed and validated results for an SSCS can be used. In addition, the concentrations of oxygen and silicon must be entered; these two concentrations are not found in standard metals analyses. The manufacturer provides silicon and oxygen concentrations for typical soil types. Pure element standards are then analyzed using a manufacturer-recommended

count time per source. The results are used to calculate correction factors in order to adjust for spectrum overlap of elements.

The working BFP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of the analysis. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. The standard sample is analyzed using a manufacturer-recommended count time per source to check the calibration curve. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A %D is then calculated for each target analyte. The %D should fall within ± 20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line the y-intercept value for the analyte. The standard sample is reanalyzed until the %D falls within ± 20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

10.3 Empirical calibration -- An empirical calibration can be performed with SSCS, site-typical standards, or standards prepared from metal oxides. A discussion of SSCS is included in Sec. 7.3; if no previously characterized samples exist for a specific site, site-typical standards can be used. Site-typical standards may be selected from commercially available characterized soils or from SSCS prepared for another site. The site-typical standards should closely approximate the site's soil matrix with respect to particle size distribution, mineralogy, and contaminant analytes. If neither SSCS nor site-typical standards are available, it is possible to make gravimetric standards by adding metal oxides to a "clean" sand or silicon dioxide matrix that simulates soil. Metal oxides can be purchased from various chemical vendors. If standards are made on site, a balance capable of weighing items to at least two decimal places is necessary. Concentrated ICP or AA standard solutions can also be used to make standards. These solutions are available in concentrations of 10,000 parts per million, thus only small volumes have to be added to the soil.

An empirical calibration using SSCS involves analysis of SSCS by the FPXRF instrument and by a conventional analytical method such as ICP or AA. A total acid digestion procedure should be used by the laboratory for sample preparation. Generally, a minimum of 10 and a maximum of 30 well characterized SSCS, site-typical standards, or prepared metal oxide standards are necessary to perform an adequate empirical calibration. The exact number of standards depends on the number of analytes of interest and interfering elements. Theoretically, an empirical calibration with SSCS should provide the most accurate data for a site because the calibration compensates for site-specific matrix effects.

The first step in an empirical calibration is to analyze the pure element standards for the elements of interest. This enables the instrument to set channel limits for each element for spectral deconvolution. Next the SSCS, site-typical standards, or prepared metal oxide standards are analyzed using a count time of 200 seconds per source or a count time recommended by the manufacturer. This will produce a spectrum and net intensity of each analyte in each standard. The analyte concentrations for each standard are then entered into the instrument software; these concentrations are those obtained from the laboratory, the certified results, or the gravimetrically determined concentrations of the prepared standards. This gives the instrument analyte values to regress against corresponding intensities during the modeling stage. The regression equation correlates the concentrations of an analyte with its net intensity.

The calibration equation is developed using a least squares fit regression analysis. After the regression terms to be used in the equation are defined, a mathematical equation can be developed to calculate the analyte concentration in an unknown sample. In some FPXRF instruments, the software of the instrument calculates the regression equation. The software uses calculated intercept and slope values to form a multiterm equation. In conjunction with the software in the instrument, the operator can adjust the multiterm equation to minimize interelement interferences and optimize the intensity calibration curve.

It is possible to define up to six linear or nonlinear terms in the regression equation. Terms can be added and deleted to optimize the equation. The goal is to produce an equation with the smallest regression error and the highest correlation coefficient. These values are automatically computed by the software as the regression terms are added, deleted, or modified. It is also possible to delete data points from the regression line if these points are significant outliers or if they are heavily weighing the data. Once the regression equation has been selected for an analyte, the equation can be entered into the software for quantitation of analytes in subsequent samples. For an empirical calibration to be acceptable, the regression equation for a specific analyte should have a correlation coefficient of 0.98 or greater or meet the DQOs of the project.

In an empirical calibration, one must apply the DQOs of the project and ascertain critical or action levels for the analytes of interest. It is within these concentration ranges or around these action levels that the FPXRF instrument should be calibrated most accurately. It may not be possible to develop a good regression equation over several orders of analyte concentration.

10.4 Compton normalization method -- The Compton normalization method is based on analysis of a single, certified standard and normalization for the Compton peak. The Compton peak is produced from incoherent backscattering of x-ray radiation from the excitation source and is present in the spectrum of every sample. The Compton peak intensity changes with differing matrices. Generally, matrices dominated by lighter elements produce a larger Compton peak, and those dominated by heavier elements produce a smaller Compton peak. Normalizing to the Compton peak can reduce problems with varying matrix effects among samples. Compton normalization is similar to the use of internal standards in organics analysis. The Compton normalization method may not be effective when analyte concentrations exceed a few percent.

The certified standard used for this type of calibration could be an NIST SRM such as 2710 or 2711. The SRM must be a matrix similar to the samples and must contain the analytes of interests at concentrations near those expected in the samples. First, a response factor has to be determined for each analyte. This factor is calculated by dividing the net peak intensity by the analyte concentration. The net peak intensity is gross intensity corrected for baseline reading. Concentrations of analytes in samples are then determined by multiplying the baseline corrected analyte signal intensity by the normalization factor and by the response factor. The normalization factor is the quotient of the baseline corrected Compton K_{α} peak intensity of the SRM divided by that of the samples. Depending on the FPXRF instrument used, these calculations may be done manually or by the instrument software.

11.0 PROCEDURE

11.1 Operation of the various FPXRF instruments will vary according to the manufacturers' protocols. Before operating any FPXRF instrument, one should consult the manufacturer's manual. Most manufacturers recommend that their instruments be allowed to warm up for 15 to 30 minutes before analysis of samples. This will help alleviate drift or energy calibration problems later during analysis.

11.2 Each FPXRF instrument should be operated according to the manufacturer's recommendations. There are two modes in which FPXRF instruments can be operated: in situ and intrusive. The in situ mode involves analysis of an undisturbed soil sediment or sample. Intrusive analysis involves collection and preparation of a soil or sediment sample before analysis. Some FPXRF instruments can operate in both modes of analysis, while others are designed to operate in only one mode. The two modes of analysis are discussed below.

11.3 For in situ analysis, remove any large or nonrepresentative debris from the soil surface before analysis. This debris includes rocks, pebbles, leaves, vegetation, roots, and concrete. Also, the soil surface must be as smooth as possible so that the probe window will have good contact with the surface. This may require some leveling of the surface with a stainless-steel trowel. During the study conducted to provide example performance data for this method, this modest amount of sample preparation was found to take less than 5 min per sample location. The last requirement is that the soil or sediment not be saturated with water. Manufacturers state that their FPXRF instruments will perform adequately for soils with moisture contents of 5 to 20 percent but will not perform well for saturated soils, especially if ponded water exists on the surface. Another recommended technique for in situ analysis is to tamp the soil to increase soil density and compactness for better repeatability and representativeness. This condition is especially important for heavy element analysis, such as barium. Source count times for in situ analysis usually range from 30 to 120 seconds, but source count times will vary among instruments and depending on the desired method sensitivity. Due to the heterogeneous nature of the soil sample, in situ analysis can provide only "screening" type data.

11.4 For intrusive analysis of surface or sediment, it is recommended that a sample be collected from a 4- by 4-inch square that is 1 inch deep. This will produce a soil sample of approximately 375 g or 250 cm³, which is enough soil to fill an 8-ounce jar. However, the exact dimensions and sample depth should take into consideration the heterogeneous deposition of contaminants and will ultimately depend on the desired project-specific data quality objectives. The sample should be homogenized, dried, and ground before analysis. The sample can be homogenized before or after drying. The homogenization technique to be used after drying is discussed in Sec. 4.2. If the sample is homogenized before drying, it should be thoroughly mixed in a beaker or similar container, or if the sample is moist and has a high clay content, it can be kneaded in a plastic bag. One way to monitor homogenization when the sample is kneaded in a plastic bag is to add sodium fluorescein dye to the sample. After the moist sample has been homogenized, it is examined under an ultraviolet light to assess the distribution of sodium fluorescein throughout the sample. If the fluorescent dye is evenly distributed in the sample, homogenization is considered complete; if the dye is not evenly distributed, mixing should continue until the sample has been thoroughly homogenized. During the study conducted to provide data for this method, the time necessary for homogenization procedure using the fluorescein dye ranged from 3 to 5 min per sample. As demonstrated in Secs. 13.5 and 13.7, homogenization has the greatest impact on the reduction of sampling variability. It produces little or no contamination. Often, the direct analysis through the plastic bag is possible without the more labor intensive steps of drying, grinding, and sieving given in Secs. 11.5 and 11.6. Of course, to achieve the best data quality possible all four steps should be followed.

11.5 Once the soil or sediment sample has been homogenized, it should be dried. This can be accomplished with a toaster oven or convection oven. A small aliquot of the sample (20 to 50 g) is placed in a suitable container for drying. The sample should be dried for 2 to 4 hr in the convection or toaster oven at a temperature not greater than 150 °C. Samples may also be air dried under ambient temperature conditions using a 10- to 20-g portion. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Care should be taken to avoid sample cross-contamination and these measures can be evaluated by including an appropriate method blank sample along with any sample preparation process.

CAUTION: Microwave drying is not a recommended procedure. Field studies have shown that microwave drying can increase variability between the FPXRF data and confirmatory analysis. High levels of metals in a sample can cause arcing in the microwave oven, and sometimes slag forms in the sample. Microwave oven drying can also melt plastic containers used to hold the sample.

11.6 The homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. The grinding step normally takes an average of 10 min per sample. An aliquot of the sieved sample should then be placed in a 31.0-mm polyethylene sample cup (or equivalent) for analysis. The sample cup should be one-half to three-quarters full at a minimum. The sample cup should be covered with a 2.5 µm Mylar (or equivalent) film for analysis. The rest of the soil sample should be placed in a jar, labeled, and archived for possible confirmation analysis. All equipment including the mortar, pestle, and sieves must be thoroughly cleaned so that any cross-contamination is below the established lower limit of detection of the procedure or DQOs of the analysis. If all recommended sample preparation steps are followed, there is a high probability the desired laboratory data quality may be obtained.

12.0 DATA ANALYSIS AND CALCULATIONS

Most FPXRF instruments have software capable of storing all analytical results and spectra. The results are displayed in ppm and can be downloaded to a personal computer, which can be used to provide a hard copy printout. Individual measurements that are smaller than three times their associated SD should not be used for quantitation. See the manufacturer's instructions regarding data analysis and calculations.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. *The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. These performance data are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.*

13.2 The sections to follow discuss three performance evaluation factors; namely, precision, accuracy, and comparability. The example data presented in Tables 4 through 8 were generated from results obtained from six FPXRF instruments (see Sec. 13.3). The soil samples analyzed by the six FPXRF instruments were collected from two sites in the United States. The soil samples contained several of the target analytes at concentrations ranging from "nondetect" to tens of thousands of mg/kg. These data are provided for guidance purposes only.

13.3 The six FPXRF instruments included the TN 9000 and TN Lead Analyzer manufactured by TN Spectrace; the X-MET 920 with a SiLi detector and X-MET 920 with a gas-filled proportional detector manufactured by Metorex, Inc.; the XL Spectrum Analyzer manufactured by Niton; and the MAP Spectrum Analyzer manufactured by Scitec. The TN 9000 and TN Lead Analyzer both have a HgI₂ detector. The TN 9000 utilized an Fe-55, Cd-109, and Am-241 source. The TN Lead Analyzer had only a Cd-109 source. The X-Met 920 with the SiLi detector had a Cd-109 and Am-241 source. The X-MET 920 with the gas-filled proportional detector had only a Cd-109 source. The XL Spectrum Analyzer utilized a silicon pin-diode

detector and a Cd-109 source. The MAP Spectrum Analyzer utilized a solid-state silicon detector and a Cd-109 source.

13.4 All example data presented in Tables 4 through 8 were generated using the following calibrations and source count times. The TN 9000 and TN Lead Analyzer were calibrated using fundamental parameters using NIST SRM 2710 as a calibration check sample. The TN 9000 was operated using 100, 60, and 60 second count times for the Cd-109, Fe-55, and Am-241 sources, respectively. The TN Lead analyzer was operated using a 60 second count time for the Cd-109 source. The X-MET 920 with the Si(Li) detector was calibrated using fundamental parameters and one well characterized site-specific soil standard as a calibration check. It used 140 and 100 second count times for the Cd-109 and Am-241 sources, respectively. The X-MET 920 with the gas-filled proportional detector was calibrated empirically using between 10 and 20 well characterized site-specific soil standards. It used 120 second times for the Cd-109 source. The XL Spectrum Analyzer utilized NIST SRM 2710 for calibration and the Compton peak normalization procedure for quantitation based on 60 second count times for the Cd-109 source. The MAP Spectrum Analyzer was internally calibrated by the manufacturer. The calibration was checked using a well-characterized site-specific soil standard. It used 240 second times for the Cd-109 source.

13.5 Precision measurements -- The example precision data are presented in Table 4. These data are provided for guidance purposes only. Each of the six FPXRF instruments performed 10 replicate measurements on 12 soil samples that had analyte concentrations ranging from "nondetects" to thousands of mg/kg. Each of the 12 soil samples underwent 4 different preparation techniques from in situ (no preparation) to dried and ground in a sample cup. Therefore, there were 48 precision data points for five of the instruments and 24 precision points for the MAP Spectrum Analyzer. The replicate measurements were taken using the source count times discussed at the beginning of this section.

For each detectable analyte in each precision sample a mean concentration, standard deviation, and RSD was calculated for each analyte. The data presented in Table 4 is an average RSD for the precision samples that had analyte concentrations at 5 to 10 times the lower limit of detection for that analyte for each instrument. Some analytes such as mercury, selenium, silver, and thorium were not detected in any of the precision samples so these analytes are not listed in Table 4. Some analytes such as cadmium, nickel, and tin were only detected at concentrations near the lower limit of detection so that an RSD value calculated at 5 to 10 times this limit was not possible.

One FPXRF instrument collected replicate measurements on an additional nine soil samples to provide a better assessment of the effect of sample preparation on precision. Table 5 shows these results. These data are provided for guidance purposes only. The additional nine soil samples were comprised of three from each texture and had analyte concentrations ranging from near the lower limit of detection for the FPXRF analyzer to thousands of mg/kg. The FPXRF analyzer only collected replicate measurements from three of the preparation methods; no measurements were collected from the in situ homogenized samples. The FPXRF analyzer conducted five replicate measurements of the in situ field samples by taking measurements at five different points within the 4-inch by 4-inch sample square. Ten replicate measurements were collected for both the intrusive undried and unground and intrusive dried and ground samples contained in cups. The cups were shaken between each replicate measurement.

Table 5 shows that the precision dramatically improved from the in situ to the intrusive measurements. In general there was a slight improvement in precision when the sample was dried and ground. Two factors caused the precision for the in situ measurements to be poorer. The major factor is soil heterogeneity. By moving the probe within the 4-inch by 4-inch square,

measurements of different soil samples were actually taking place within the square. Table 5 illustrates the dominant effect of soil heterogeneity. It overwhelmed instrument precision when the FPXRF analyzer was used in this mode. The second factor that caused the RSD values to be higher for the in situ measurements is the fact that only five instead of ten replicates were taken. A lesser number of measurements caused the standard deviation to be larger which in turn elevated the RSD values.

13.6 Accuracy measurements -- Five of the FPXRF instruments (not including the MAP Spectrum Analyzer) analyzed 18 SRMs using the source count times and calibration methods given at the beginning of this section. The 18 SRMs included 9 soil SRMs, 4 stream or river sediment SRMs, 2 sludge SRMs, and 3 ash SRMs. Each of the SRMs contained known concentrations of certain target analytes. A percent recovery was calculated for each analyte in each SRM for each FPXRF instrument. Table 6 presents a summary of this data. With the exception of cadmium, chromium, and nickel, the values presented in Table 6 were generated from the 13 soil and sediment SRMs only. The 2 sludge and 3 ash SRMs were included for cadmium, chromium, and nickel because of the low or nondetectable concentrations of these three analytes in the soil and sediment SRMs.

Only 12 analytes are presented in Table 6. These are the analytes that are of environmental concern and provided a significant number of detections in the SRMs for an accuracy assessment. No data is presented for the X-MET 920 with the gas-filled proportional detector. This FPXRF instrument was calibrated empirically using site-specific soil samples. The percent recovery values from this instrument were very sporadic and the data did not lend itself to presentation in Table 6.

Table 7 provides a more detailed summary of accuracy data for one particular FPXRF instrument (TN 9000) for the 9 soil SRMs and 4 sediment SRMs. These data are provided for guidance purposes only. Table 7 shows the certified value, measured value, and percent recovery for five analytes. These analytes were chosen because they are of environmental concern and were most prevalently certified for in the SRM and detected by the FPXRF instrument. The first nine SRMs are soil and the last 4 SRMs are sediment. Percent recoveries for the four NIST SRMs were often between 90 and 110 percent for all analytes.

13.7 Comparability -- Comparability refers to the confidence with which one data set can be compared to another. In this case, FPXRF data generated from a large study of six FPXRF instruments was compared to SW-846 Methods 3050 and 6010 which are the standard soil extraction for metals and analysis by inductively coupled plasma. An evaluation of comparability was conducted by using linear regression analysis. Three factors were determined using the linear regression. These factors were the y-intercept, the slope of the line, and the coefficient of determination (r^2).

As part of the comparability assessment, the effects of soil type and preparation methods were studied. Three soil types (textures) and four preparation methods were examined during the study. The preparation methods evaluated the cumulative effect of particle size, moisture, and homogenization on comparability. Due to the large volume of data produced during this study, linear regression data for six analytes from only one FPXRF instrument is presented in Table 8. Similar trends in the data were seen for all instruments. These data are provided for guidance purposes only.

Table 8 shows the regression parameters for the whole data set, broken out by soil type, and by preparation method. These data are provided for guidance purposes only. The soil types are as follows: soil 1--sand; soil 2--loam; and soil 3--silty clay. The preparation methods are as follows: preparation 1--in situ in the field; preparation 2--intrusive, sample collected and homogenized; preparation 3--intrusive, with sample in a sample cup but sample still wet and not

ground; and preparation 4—intrusive, with sample dried, ground, passed through a 40-mesh sieve, and placed in sample cup.

For arsenic, copper, lead, and zinc, the comparability to the confirmatory laboratory was excellent with r^2 values ranging from 0.80 to 0.99 for all six FPXRF instruments. The slopes of the regression lines for arsenic, copper, lead, and zinc, were generally between 0.90 and 1.00 indicating the data would need to be corrected very little or not at all to match the confirmatory laboratory data. The r^2 values and slopes of the regression lines for barium and chromium were not as good as for the other for analytes, indicating the data would have to be corrected to match the confirmatory laboratory.

Table 8 demonstrates that there was little effect of soil type on the regression parameters for any of the six analytes. The only exceptions were for barium in soil 1 and copper in soil 3. In both of these cases, however, it is actually a concentration effect and not a soil effect causing the poorer comparability. All barium and copper concentrations in soil 1 and 3, respectively, were less than 350 mg/kg.

Table 8 shows there was a preparation effect on the regression parameters for all six analytes. With the exception of chromium, the regression parameters were primarily improved going from preparation 1 to preparation 2. In this step, the sample was removed from the soil surface, all large debris was removed, and the sample was thoroughly homogenized. The additional two preparation methods did little to improve the regression parameters. This data indicates that homogenization is the most critical factor when comparing the results. It is essential that the sample sent to the confirmatory laboratory match the FPXRF sample as closely as possible.

Sec. 11.0 of this method discusses the time necessary for each of the sample preparation techniques. Based on the data quality objectives for the project, an analyst must decide if it is worth the extra time necessary to dry and grind the sample for small improvements in comparability. Homogenization requires 3 to 5 min. Drying the sample requires one to two hours. Grinding and sieving requires another 10 to 15 min per sample. Lastly, when grinding and sieving is conducted, time has to be allotted to decontaminate the mortars, pestles, and sieves. Drying and grinding the samples and decontamination procedures will often dictate that an extra person be on site so that the analyst can keep up with the sample collection crew. The cost of requiring an extra person on site to prepare samples must be balanced with the gain in data quality and sample throughput.

13.8 The following documents may provide additional guidance and insight on this method and technique:

13.8.1 A. D. Hewitt, "Screening for Metals by X-ray Fluorescence Spectrometry/Response Factor/Compton K_α Peak Normalization Analysis," American Environmental Laboratory, pp 24-32, 1994.

13.8.2 S. Piorek and J. R. Pasmore, "Standardless, In Situ Analysis of Metallic Contaminants in the Natural Environment With a PC-Based, High Resolution Portable X-Ray Analyzer," Third International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, Las Vegas, Nevada, February 24-26, 1993, Vol 2, pp 1135-1151, 1993.

13.8.3 S. Shefsky, "Sample Handling Strategies for Accurate Lead-in-soil Measurements in the Field and Laboratory," *International Symposium of Field Screening Methods for Hazardous Waste and Toxic Chemicals*, Las Vegas, NV, January 29-31, 1997.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th St., N.W. Washington, D.C. 20036, <http://www.acs.org>.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. Metorex, X-MET 920 User's Manual.
2. Spectrace Instruments, "Energy Dispersive X-ray Fluorescence Spectrometry: An Introduction," 1994.
3. TN Spectrace, Spectrace 9000 Field Portable/Benchtop XRF Training and Applications Manual.
4. Unpublished SITE data, received from PRC Environment Management, Inc.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method. A flow diagram of the procedure follows the tables.

TABLE 1

EXAMPLE INTERFERENCE FREE LOWER LIMITS OF DETECTION

Analyte	Chemical Abstract Series Number	Lower Limit of Detection in Quartz Sand (milligrams per kilogram)
Antimony (Sb)	7440-36-0	40
Arsenic (As)	7440-38-0	40
Barium (Ba)	7440-39-3	20
Cadmium (Cd)	7440-43-9	100
Calcium (Ca)	7440-70-2	70
Chromium (Cr)	7440-47-3	150
Cobalt (Co)	7440-48-4	60
Copper (Cu)	7440-50-8	50
Iron (Fe)	7439-89-6	60
Lead (Pb)	7439-92-1	20
Manganese (Mn)	7439-96-5	70
Mercury (Hg)	7439-97-6	30
Molybdenum (Mo)	7439-93-7	10
Nickel (Ni)	7440-02-0	50
Potassium (K)	7440-09-7	200
Rubidium (Rb)	7440-17-7	10
Selenium (Se)	7782-49-2	40
Silver (Ag)	7440-22-4	70
Strontium (Sr)	7440-24-6	10
Thallium (Tl)	7440-28-0	20
Thorium (Th)	7440-29-1	10
Tin (Sn)	7440-31-5	60
Titanium (Ti)	7440-32-6	50
Vanadium (V)	7440-62-2	50
Zinc (Zn)	7440-66-6	50
Zirconium (Zr)	7440-67-7	10

Source: Refs. 1, 2, and 3

These data are provided for guidance purposes only.

TABLE 2
SUMMARY OF RADIOISOTOPE SOURCE CHARACTERISTICS

Source	Activity (mCi)	Half-Life (Years)	Excitation Energy (keV)	Elemental Analysis Range	
Fe-55	20-50	2.7	5.9	Sulfur to Chromium Molybdenum to Barium	K Lines L Lines
Cd-109	5-30	1.3	22.1 and 87.9	Calcium to Rhodium Tantalum to Lead Barium to Uranium	K Lines K Lines L Lines
Am-241	5-30	432	26.4 and 59.6	Copper to Thulium Tungsten to Uranium	K Lines L Lines
Cm-244	60-100	17.8	14.2	Titanium to Selenium Lanthanum to Lead	K Lines L Lines

Source: Refs. 1, 2, and 3

TABLE 3
SUMMARY OF X-RAY TUBE SOURCE CHARACTERISTICS

Anode Material	Recommended Voltage Range (kV)	K-alpha Emission (keV)	Elemental Analysis Range	
Cu	18-22	8.04	Potassium to Cobalt Silver to Gadolinium	K Lines L Lines
Mo	40-50	17.4	Cobalt to Yttrium Europium to Radon	K Lines L Lines
Ag	50-65	22.1	Zinc to Technicium Ytterbium to Neptunium	K Lines L Lines

Source: Ref. 4

Notes: The sample elements excited are chosen by taking as the lower limit the same ratio of excitation line energy to element absorption edge as in Table 2 (approximately 0.45) and the requirement that the excitation line energy be above the element absorption edge as the upper limit (L2 edges used for L lines). K-beta excitation lines were ignored.

TABLE 4
EXAMPLE PRECISION VALUES

Analyte	Average Relative Standard Deviation for Each Instrument at 5 to 10 Times the Lower Limit of Detection					
	TN 9000	TN Lead Analyzer	X-MET 920 (SiLi Detector)	X-MET 920 (Gas-Filled Detector)	XL Spectrum Analyzer	MAP Spectrum Analyzer
Antimony	6.54	NR	NR	NR	NR	NR
Arsenic	5.33	4.11	3.23	1.91	12.47	6.68
Barium	4.02	NR	3.31	5.91	NR	NR
Cadmium	29.84 ^a	NR	24.80 ^a	NR	NR	NR
Calcium	2.16	NR	NR	NR	NR	NR
Chromium	22.25	25.78	22.72	3.91	30.25	NR
Cobalt	33.90	NR	NR	NR	NR	NR
Copper	7.03	9.11	8.49	9.12	12.77	14.86
Iron	1.78	1.67	1.55	NR	2.30	NR
Lead	6.45	5.93	5.05	7.56	6.97	12.16
Manganese	27.04	24.75	NR	NR	NR	NR
Molybdenum	6.95	NR	NR	NR	12.60	NR
Nickel	30.85 ^a	NR	24.92 ^a	20.92 ^a	NA	NR
Potassium	3.90	NR	NR	NR	NR	NR
Rubidium	13.06	NR	NR	NR	32.69 ^a	NR
Strontium	4.28	NR	NR	NR	8.86	NR
Tin	24.32 ^a	NR	NR	NR	NR	NR
Titanium	4.87	NR	NR	NR	NR	NR
Zinc	7.27	7.48	4.26	2.28	10.95	0.83
Zirconium	3.58	NR	NR	NR	6.49	NR

These data are provided for guidance purposes only.

Source: Ref. 4

^a These values are biased high because the concentration of these analytes in the soil samples was near the lower limit of detection for that particular FPXRF instrument.

NR Not reported.

NA Not applicable; analyte was reported but was below the established lower limit detection.

TABLE 5

EXAMPLES OF PRECISION AS AFFECTED BY SAMPLE PREPARATION

Analyte	Average Relative Standard Deviation for Each Preparation Method		
	In Situ-Field	Intrusive- Undried and Unground	Intrusive- Dried and Ground
Antimony	30.1	15.0	14.4
Arsenic	22.5	5.36	3.76
Barium	17.3	3.38	2.90
Cadmium ^a	41.2	30.8	28.3
Calcium	17.5	1.68	1.24
Chromium	17.6	28.5	21.9
Cobalt	28.4	31.1	28.4
Copper	26.4	10.2	7.90
Iron	10.3	1.67	1.57
Lead	25.1	8.55	6.03
Manganese	40.5	12.3	13.0
Mercury	ND	ND	ND
Molybdenum	21.6	20.1	19.2
Nickel ^a	29.8	20.4	18.2
Potassium	18.6	3.04	2.57
Rubidium	29.8	16.2	18.9
Selenium	ND	20.2	19.5
Silver ^a	31.9	31.0	29.2
Strontium	15.2	3.38	3.98
Thallium	39.0	16.0	19.5
Thorium	NR	NR	NR
Tin	ND	14.1	15.3
Titanium	13.3	4.15	3.74
Vanadium	NR	NR	NR
Zinc	26.6	13.3	11.1
Zirconium	20.2	5.63	5.18

These data are provided for guidance purposes only.

Source: Ref. 4

^a These values may be biased high because the concentration of these analytes in the soil samples was near the lower limit of detection.

ND Not detected.

NR Not reported.

TABLE 6
EXAMPLE ACCURACY VALUES

Analyte	Instrument															
	TN 9000				TN Lead Analyzer				X-MET 920 (SiLi Detector)				XL Spectrum Analyzer			
	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD
Sb	2	100-149	124.3	NA	--	--	--	--	--	--	--	--	--	--	--	--
As	5	68-115	92.8	17.3	5	44-105	83.4	23.2	4	9.7-91	47.7	39.7	5	38-535	189.8	206
Ba	9	98-198	135.3	36.9	--	--	--	--	9	18-848	168.2	262	--	--	--	--
Cd	2	99-129	114.3	NA	--	--	--	--	6	81-202	110.5	45.7	--	--	--	--
Cr	2	99-178	138.4	NA	--	--	--	--	7	22-273	143.1	93.8	3	98-625	279.2	300
Cu	8	61-140	95.0	28.8	6	38-107	79.1	27.0	11	10-210	111.8	72.1	8	95-480	203.0	147
Fe	6	78-155	103.7	26.1	6	89-159	102.3	28.6	6	48-94	80.4	16.2	6	26-187	108.6	52.9
Pb	11	66-138	98.9	19.2	11	68-131	97.4	18.4	12	23-94	72.7	20.9	13	80-234	107.3	39.9
Mn	4	81-104	93.1	9.70	3	92-152	113.1	33.8	--	--	--	--	--	--	--	--
Ni	3	99-122	109.8	12.0	--	--	--	--	--	--	--	--	3	57-123	87.5	33.5
Sr	8	110-178	132.6	23.8	--	--	--	--	--	--	--	--	7	86-209	125.1	39.5
Zn	11	41-130	94.3	24.0	10	81-133	100.0	19.7	12	46-181	106.6	34.7	11	31-199	94.6	42.5

Source: Ref. 4. These data are provided for guidance purposes only.

n: Number of samples that contained a certified value for the analyte and produced a detectable concentration from the FPXRF instrument.

SD: Standard deviation; NA: Not applicable; only two data points, therefore, a SD was not calculated.

%Rec.: Percent recovery.

-- No data.

TABLE 7

EXAMPLE ACCURACY FOR TN 9000^a

Standard Reference Material	Arsenic			Barium			Copper			Lead			Zinc		
	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.
RTC CRM-021	24.8	ND	NA	586	1135	193.5	4792	2908	60.7	144742	149947	103.6	546	224	40.9
RTC CRM-020	397	429	92.5	22.3	ND	NA	753	583	77.4	5195	3444	66.3	3022	3916	129.6
BCR CRM 143R	--	--	--	--	--	--	131	105	80.5	180	206	114.8	1055	1043	99.0
BCR CRM 141	--	--	--	--	--	--	32.6	ND	NA	29.4	ND	NA	81.3	ND	NA
USGS GXR-2	25.0	ND	NA	2240	2946	131.5	76.0	106	140.2	690	742	107.6	530	596	112.4
USGS GXR-6	330	294	88.9	1300	2581	198.5	66.0	ND	NA	101	80.9	80.1	118	ND	NA
NIST 2711	105	104	99.3	726	801	110.3	114	ND	NA	1162	1172	100.9	350	333	94.9
NIST 2710	626	722	115.4	707	782	110.6	2950	2834	96.1	5532	5420	98.0	6952	6476	93.2
NIST 2709	17.7	ND	NA	968	950	98.1	34.6	ND	NA	18.9	ND	NA	106	98.5	93.0
NIST 2704	23.4	ND	NA	414	443	107.0	98.6	105	106.2	161	167	103.5	438	427	97.4
CNRC PACS-1	211	143	67.7	--	772	NA	452	302	66.9	404	332	82.3	824	611	74.2
SARM-51	--	--	--	335	466	139.1	268	373	139.2	5200	7199	138.4	2200	2676	121.6
SARM-52	--	--	--	410	527	128.5	219	193	88.1	1200	1107	92.2	264	215	81.4

Source: Ref. 4. These data are provided for guidance purposes only.

^a All concentrations in milligrams per kilogram.

%Rec.: Percent recovery; ND: Not detected; NA: Not applicable.

-- No data.

TABLE 8

EXAMPLE REGRESSION PARAMETERS FOR COMPARABILITY¹

	Arsenic				Barium				Copper			
	n	r ²	Int.	Slope	n	r ²	Int.	Slope	n	r ²	Int.	Slope
All Data	824	0.94	1.62	0.94	1255	0.71	60.3	0.54	984	0.93	2.19	0.93
Soil 1	368	0.96	1.41	0.95	393	0.05	42.6	0.11	385	0.94	1.26	0.99
Soil 2	453	0.94	1.51	0.96	462	0.56	30.2	0.66	463	0.92	2.09	0.95
Soil 3	—	—	—	—	400	0.85	44.7	0.59	136	0.46	16.60	0.57
Prep 1	207	0.87	2.69	0.85	312	0.64	53.7	0.55	256	0.87	3.89	0.87
Prep 2	208	0.97	1.38	0.95	315	0.67	64.6	0.52	246	0.96	2.04	0.93
Prep 3	204	0.96	1.20	0.99	315	0.78	64.6	0.53	236	0.97	1.45	0.99
Prep 4	205	0.96	1.45	0.98	313	0.81	58.9	0.55	246	0.96	1.99	0.96

	Lead				Zinc				Chromium			
	n	r ²	Int.	Slope	n	r ²	Int.	Slope	n	r ²	Int.	Slope
All Data	1205	0.92	1.66	0.95	1103	0.89	1.86	0.95	280	0.70	64.6	0.42
Soil 1	357	0.94	1.41	0.96	329	0.93	1.78	0.93	—	—	—	—
Soil 2	451	0.93	1.62	0.97	423	0.85	2.57	0.90	—	—	—	—
Soil 3	397	0.90	2.40	0.90	351	0.90	1.70	0.98	186	0.66	38.9	0.50
Prep 1	305	0.80	2.88	0.86	286	0.79	3.16	0.87	105	0.80	66.1	0.43
Prep 2	298	0.97	1.41	0.96	272	0.95	1.86	0.93	77	0.51	81.3	0.36
Prep 3	302	0.98	1.26	0.99	274	0.93	1.32	1.00	49	0.73	53.7	0.45
Prep 4	300	0.96	1.38	1.00	271	0.94	1.41	1.01	49	0.75	31.6	0.56

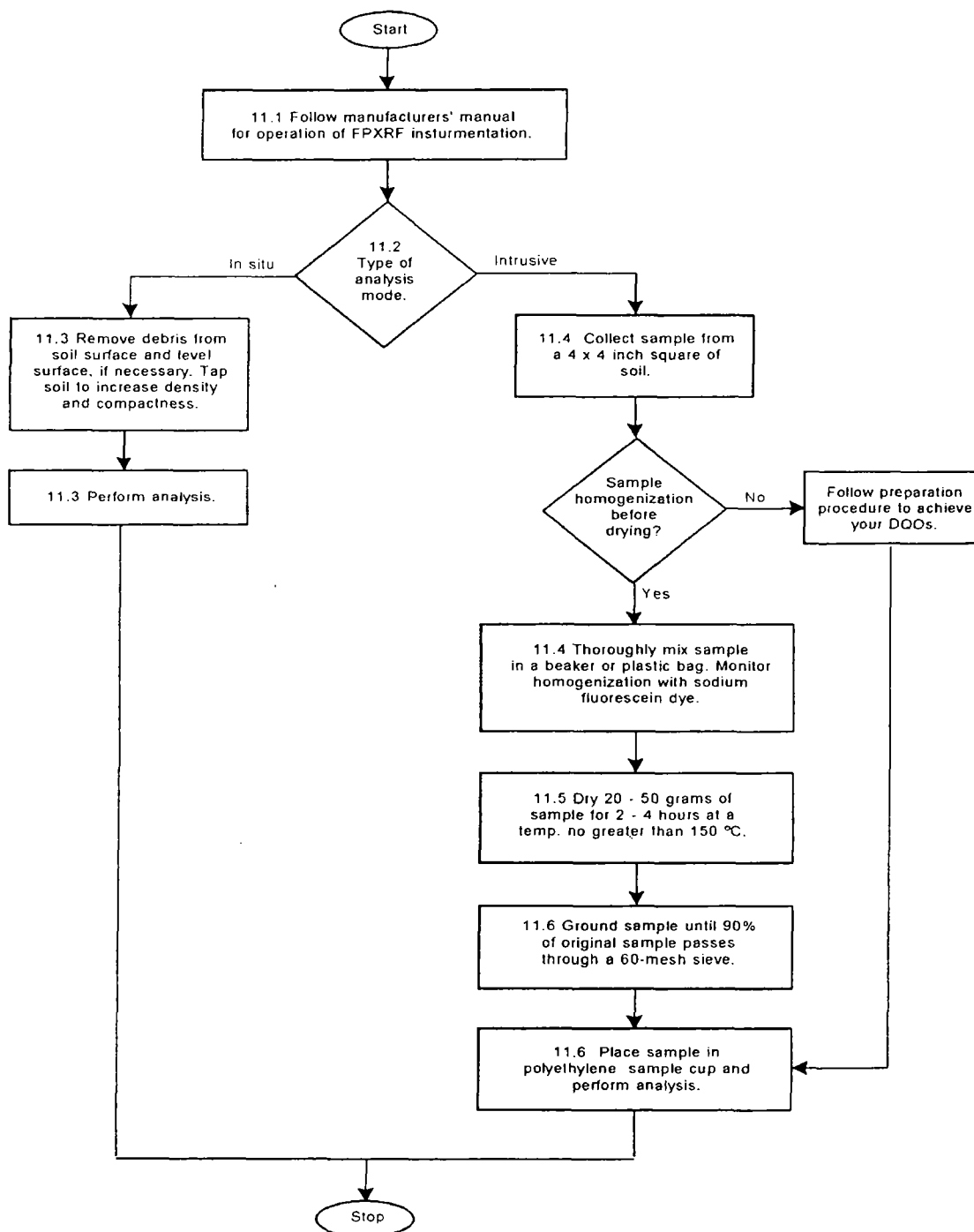
Source: Ref. 4. These data are provided for guidance purposes only.

¹ Log-transformed datan: Number of data points; r²: Coefficient of determination; Int.: Y-intercept

— No applicable data

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



ARCADIS

Appendix E

Determination of the Correlation
Coefficient

**Appendix E. Determination of the Correlation Coefficient, U.S. Coast Guard, Old Station Ludington
Ludington, Michigan**

Excavation Area	Sample ID	Laboratory Results	Field Screening Results
		Total Lead (mg/kg)	Lead XRF Reading (ppm)
Excavation 1	SLRC 010004	22	30
Excavation 1	SLRC 010005	59	42
Excavation 1	SLRC 010006	240	260
Excavation 1	SLRC 010007	45	33
Excavation 1	SLRC 010012	63	82
Excavation 2	SLRC 020001	35	38
Excavation 2	SLRC 020002	13	17
Excavation 2	SLRC 020004	31	34
Excavation 2	SLRC 020005	83	75
Excavation 2	SLRC 020005	57	65
Excavation 2	SLRC 020006	91	89
Excavation 3	SLRC 030001	26	24
Excavation 3	SLRC 030002	200	132
Excavation 3	SLRC 030002	120	128
Excavation 3	SLRC 030003	12	10
Excavation 3	SLRC 030004	110	160
Excavation 3	SLRC 030005	18	25
Excavation 3	SLRC 030006	94	261
Excavation 4	SLRC 040001	150	158
Excavation 4	SLRC 040002	66	65
Excavation 4	SLRC 040004	260	243
Excavation 4	SLRC 040005	81	93
Excavation 4	SLRC 040006	210	223
Excavation 4	SLRC 040007	56	60
Excavation 4	SLRC 040007	53	51
Excavation 4	SLRC 040008	93	63
Excavation 4	SLRC 040010	47	50
Excavation 4	SLRC 040011	61	24
Excavation 5	SLRC 050001	200	151
Excavation 5	SLRC 050002	180	156
Excavation 5	SLRC 050003	29	26
Excavation 5	SLRC 050004	82	81
Excavation 5	SLRC 050005	120	115
Excavation 5	SLRC 050006	230	186
Excavation 5	SLRC 050007	190	141

Correlation Coefficient: 0.87

Notes:

All soil samples were prepared and analyzed in accordance with the QAPP (ARCADIS U.S., Inc 2008a), FSP (ARCADIS U.S., Inc. 2008b), and QAPP Addendum (ARCADIS U.S., Inc. 2009c).

ft bgs Feet below ground surface.
mg/kg Milligrams per kilogram.
ppm Parts per million.
XRF X-Ray fluorescence.

ARCADIS

Appendix F

Laboratory Analytical and Data
Validation Reports

**US Coast Guard Station
Ludington**

Data Review

LUDINGTON, MICHIGAN

Metals Analyses

SDGs# WRK0541, WSB0399, WSE0595

Analyses Performed By:
TestAmerica Laboratories
Watertown, Wisconsin

Report: #10726R1
Review Level: Tier III
Project: DE000122.0002.00004

SUMMARY

This data quality assessment summarizes the review of Sample Delivery Groups (SDGs) #WRK0541, WSB0399 and WSE0595 for samples collected in association with the USCG Station Ludington site. The review was conducted as a Tier III evaluation and included review of data package completeness. Only analytical data associated with constituents of concern were reviewed for this validation. Field documentation was not included in this review. Included with this assessment are the validation annotated sample result sheets, and chain of custody. Analyses were performed on the following samples:

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis			
						VOC	SVOC	PCB	MET
WRK0541	SLMW-01-NOV2008-SE	WRK0541-01	Water	11/12/2008					X
WRK0541	SLMW-02-NOV2008-SE	WRK0541-02	Water	11/12/2008					X
WRK0541	SLMW-03-NOV2008-SE	WRK0541-03	Water	11/12/2008					X
WRK0541	SLDUP-01-NOV2008-SE	WRK0541-04	Water	11/12/2008	SLMW-03-NOV2008-SE				X
WSB0399	SLMW-03 Feb 2009-SE	WSB0399-01	Water	2/9/2009					X
WSB0399	SLMW-02 Feb 2009-SE	WSB0399-02	Water	2/9/2009					X
WSB0399	SLMW-01 Feb 2009-SE	WSB0399-03	Water	2/9/2009					X
WSB0399	MW-DUP-01 Feb 2009-SE	WSB0399-04	Water	2/9/2009	SLMW-03 Feb 2009-SE				X
WSB0399	MW-EB-01 Feb 2009-SE	WSB0399-05	Water	2/9/2009					X
WSE0595	SLMW01 May 2009 SE	WSE0595-01	Water	5/18/2009					X
WSE0595	SLMW02 May 2009 SE	WSE0595-02	Water	5/18/2009					X
WSE0595	SLMW03 May 2009 SE	WSE0595-03	Water	5/18/2009					X
WSE0595	MW Dup01 May 2009 SE	WSE0595-04	Water	5/18/2009	SLMW03 May 2009 SE				X
WSE0595	MW EB01 May 2009 SE	WSE0595-05	Water	5/18/2009					X

Note:

1. Metals includes total and dissolved lead.
2. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample locations SLMW-01-NOV2008-SE, SLMW-01 FEB2009-SE and SLMW01 MAY2009-SE.

ANALYTICAL DATA PACKAGE DOCUMENTATION

The table below is the evaluation of the data package completeness.

Items Reviewed	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
1. Sample receipt condition		X		X	
2. Requested analyses and sample results		X		X	
3. Master tracking list		X		X	
4. Methods of analysis		X		X	
5. Reporting limits		X		X	
6. Sample collection date		X		X	
7. Laboratory sample received date		X		X	
8. Sample preservation verification (as applicable)		X		X	
9. Sample preparation/extraction/analysis dates		X		X	
10. Fully executed Chain-of-Custody (COC) form		X		X	
11. Narrative summary of QA or sample problems provided		X		X	
12. Data Package Completeness and Compliance		X		X	

QA - Quality Assurance

INORGANIC ANALYSIS INTRODUCTION

Analyses were performed according to United States Environmental Protection Agency (USEPA) SW-846 Methods 6020A. Data were reviewed in accordance with USEPA National Functional Guidelines of July 2002.

The data review process is an evaluation of data on a technical basis rather than a determination of contract compliance. As such, the standards against which the data are being weighed may differ from those specified in the analytical method. It is assumed that the data package represents the best efforts of the laboratory and that it was already subjected to adequate and sufficient quality review prior to submission.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results are qualified with the following codes in accordance with the USEPA National Functional Guidelines:

- Concentration (C) Qualifiers
 - U The analyte was analyzed for but not detected. The associated value is the analyte instrument detection limit.
 - B The reported value was obtained from a reading less than the contract-required detection limit (CRDL), but greater than or equal to the instrument detection limit (IDL).
- Quantitation (Q) Qualifiers
 - E The reported value is estimated due to the presence of interference.
 - N Spiked sample recovery is not within control limits.
 - * Duplicate analysis is not within control limits.
- Validation Qualifiers
 - J The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
 - UJ The analyte was not detected above the reported sample detection limit. However, the reported limit is approximate and may or may not represent the actual limit of detection.
 - UB Analyte considered non-detect at the listed value due to associated blank contamination.
 - R The sample results are rejected.

Two facts should be noted by all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant quality control (QC) problems, the analysis is invalid and provides no information as to whether the compound is present or not. "R" values should not appear on data tables because they cannot be relied upon, even as a last resort. The second fact to keep in mind is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data but any value potentially contains error.

METALS ANALYSES

1. Holding Times

The specified holding times for the following methods are presented in the following table.

Method	Matrix	Holding Time	Preservation
SW-846 6020A	Water	180 days from collection to analysis	Cooled @ 4 °C; preserved to a pH of less than 2.
	Soil	180 days from collection to analysis	Cooled @ 4 °C.

All samples were analyzed within the specified holding times.

2. Blank Contamination

Quality assurance (QA) blanks (i.e., method and rinse blanks) are prepared to identify any contamination which may have been introduced into the samples during sample preparation or field activity. Method blanks measure laboratory contamination. Rinse blanks measure contamination of samples during field operations.

A blank action level (BAL) of five times the concentration of a detected compound in an associated blank (common laboratory contaminant compounds are calculated at ten times) is calculated for QA blanks containing concentrations greater than the method detection limit (MDL). The BAL is compared to the associated sample results to determine the appropriate qualification of the sample results, if needed.

All analytes associated with the QA blanks exhibited a concentration less than the MDL, with the exception of the analytes listed in the following table. Sample results less than the BAL associated with the following sample locations were qualified as listed in the following table.

Sample Locations	Analytes	Sample Result	Qualification
SLMW03 MAY2009-SE	Lead (T)	Detected sample results <RL and <BAL	"UB" at the RL

RL = reporting limit

3. Calibration

Satisfactory instrument calibration is established to provide that the instrument is capable of producing acceptable quantitative data. An initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of an experimental sequence. The continuing calibration verifies that the instrument's continuing performance is satisfactory.

3.1 Initial Calibration and Continuing Calibration

The correct number and type of standards were analyzed. The correlation coefficient of the initial calibration was greater than 0.995 for all non-ICP analytes and all initial calibration verification standard recoveries were within control limits.

All continuing calibration verification standard recoveries were within the control limit.

3.2 CRDL Check Standard

The CRDL check standard serves to verify the linearity of calibration of the analysis at the CRDL. The CRDL standard is not required for the analysis of aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), and potassium (K). The criteria used to evaluate the CRDL standard analysis are presented below in the CRDL standards evaluation table.

All CRDL standard recoveries were within control limits.

3.3 ICP Interference Control Sample (ICS)

The ICS verifies the laboratories interelement and background correction factors.

All ICS exhibited recoveries within the control limits.

4. Matrix Spike/Matrix Spike (MS/MSD) Analysis

MS/MSD data are used to assess the precision and accuracy of the analytical method.

4.1 MS/MSD Analysis

All metal analytes must exhibit a percent recovery within the established acceptance limits of 75% to 125%. The MS/MSD recovery control limits do not apply for MS/MSD performed on sample locations where the analyte's concentration detected in the parent sample exceeds the MS/MSD concentration by a factor of four or greater. In instance where this is true, the data will not be qualified even if the percent recovery does not meet the control limits and the laboratory qualifier "N" will be removed.

The MS/MSD analysis performed on sample locations SLMW-01-NOV2008-SE, SLMW-01 FEB2009-SE and SLMW01 MAY2009-SE exhibited recoveries within the control limits.

5. Field Duplicate Analysis

Field duplicate analysis is used to assess the precision and accuracy of the field sampling procedures and analytical method. A control limit of 50% for water matrices is applied to the RPD between the parent sample and the field duplicate. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the RL, a control limit of two times the RL is applied for water matrices.

Results for duplicate samples are summarized in the following table.

Sample ID/Duplicate ID	Analyte	Sample Result	Duplicate Result	RPD
SLMW-03-NOV2008-SE/ SLDUP-01-NOV2008-SE	Lead	ND(0.12)	ND(0.12)	AC
SLMW-03 Feb 2009-SE/ MW-DUP-01 Feb 2009-SE	Lead	ND(0.12)	ND(0.12)	AC
SLMW03 May 2009 SE/ MW Dup01 May 2009 SE	Lead	0.14 J	ND(0.12)	AC

ND = Not detected

AC = Acceptable

The calculated RPDs between the parent sample and field duplicate were acceptable.

6. Laboratory Control Sample (LCS) Analysis

The LCS analysis is used to assess the precision and accuracy of the analytical method independent of matrix interferences. The analytes associated with the LCS analysis must exhibit a percent recovery between the control limits of 80% and 120%.

The LCS analysis exhibited recoveries within the control limits.

7. Serial Dilution

The serial dilution analysis is used to assess if a significant physical or chemical interference exists due to sample matrix. Analytes exhibiting concentrations greater than 50 times the MDL in the undiluted sample are evaluated to determine if matrix interference exists. These analytes are required to have less than a 10% difference (%D) between sample results from the undiluted (parent) sample and results associated with the same sample analyzed with a five-fold dilution.

A serial dilution was not required since the lead concentration was not greater than 50 times the MDL.

8. System Performance and Overall Assessment

The calculated %D between the total and the dissolved sample results were within the control limit.

Overall system performance was acceptable. Other than for those deviations specifically mentioned in this review, the overall data quality is within the guidelines specified in the method.

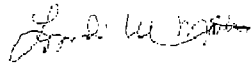
DATA VALIDATION CHECKLIST FOR METAL

METALS; SW-846 6000	Reported		Performance Acceptable		Not Required	
	No	Yes	No	Yes		
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)						
Tier II Validation						
Holding Times		X		X		
Reporting limits (units)		X		X		
Blanks						
A. Instrument Blanks					X	
B. Method Blanks		X		X		
C. Equipment Blanks		X	X			
Laboratory Control Sample (LCS)		X		X		
Matrix Spike (MS) %R		X		X		
Matrix Spike Duplicate (MSD) %R		X		X		
MS/MSD Precision (RPD)		X		X		
Field Duplicate (RPD)		X		X		
ICP Serial Dilution					X	
Reporting Limit Verification		X		X		
Raw Data					X	
Tier III Validation						
Initial Calibration Verification		X		X		
Continuing Calibration Verification		X		X		
CRDL Standard		X		X		
ICP Interference Check		X		X		
Transcription/calculation errors present				X		
Reporting limits adjusted to reflect sample dilutions		X		X		

%R Percent recovery
 RPD Relative percent difference

VALIDATION PERFORMED BY: Lyndi Mott

SIGNATURE:



DATE: September 8, 2009

REVISION DATE: November 27, 2009

PEER REVIEW: Dennis Capria

DATE: September 16, 2009

**CHAIN OF CUSTODY/
CORRECTED SAMPLE ANALYSIS DATA SHEETS**

WRK 0541

THE LEADER IN ENVIRONMENTAL TESTING

THE LEADER IN ENVIRONMENTAL TESTING

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

02/11/08

ID#: 12357

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page 1 of 1

Lab Work Order # **WSB0399**

Send Results to:	Contact & Company Name: Troy Scatani / ARCADIS		Telephone: 248-994-2288		Preservative: HNO3 HNO3																																																																																						
	Address: 28550 Cabot Dr		Fax: 248-994-2241		Filtered (✓):																																																																																						
	City, State, Zip: Novi MI 48377		E-mail Address: Troy.Scatani@arcadis-us.com		# of Containers: 7		Container Information: 250ml 250ml																																																																																				
Project Name/Location (City, State): USCG Station Ludington, MI		Project #: DE000122.0001.00003		PARAMETER ANALYSIS & METHOD																																																																																							
Sampler's Printed Name: Amy O'Neil		Sampler's Signature: <i>Amy O'Neil</i>																																																																																									
Sample ID		Collection		Type (✓)		Matrix		<div style="display: flex; justify-content: space-around;"> <div>5m 6020A total lead</div> <div>5m 6020A dissolved lead</div> </div>																																																																																			
Date, Time		Comp, Grab																																																																																									
-01	SLHW-03Feb2009-SE	02/09/09 1705	✓	GW	1	1																																																																																					
-02	SLHW-02Feb2009-SE	02/09/09 1625	✓	GW	1	1																																																																																					
-03	SLHW-01Feb2009-SE	02/09/09 1530	✓	GW	3	3	MS/MSD																																																																																				
-04	MWDUP01Feb2009-SE	02/09/09 -	✓	GW	1	1																																																																																					
-05	MNEBO1Feb2009-SE	02/09/09 1720	✓	GW	1	1																																																																																					
Special Instructions/Comments: Standard TAT																																																																																											
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Laboratory Information and Receipt				Relinquished By		Received By		Relinquished By		Laboratory Received By																																																																																	
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2/13/09

O'Dee Field



WSE0595

Paragon Report No.

12649 Richfield Court • Livonia, MI 48150 • (734) 462-3900 • Fax (734) 462-3911

Page 1 of 1[illegible]

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WRK0541
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 11/18/08
Reported: 11/21/08 14:26

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WRK0541-01 (SLMW-01-NOV2008-SE - Ground Water)						Sampled: 11/12/08 14:20				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-02 (SLMW-02-NOV2008-SE - Ground Water)						Sampled: 11/12/08 15:05				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-03 (SLMW-03-NOV2008-SE - Ground Water)						Sampled: 11/12/08 15:50				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-04 (SLDUP-01-NOV2008-SE - Ground Water)						Sampled: 11/12/08				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSB0399-01 (SLMW-03 Feb 2009-SE - Ground Water)						Sampled: 02/09/09 17:05				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-02 (SLMW-02 Feb 2009-SE - Ground Water)						Sampled: 02/09/09 16:25				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-03 (SLMW-01 Feb 2009-SE - Ground Water)						Sampled: 02/09/09 15:30				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	0.13	J	ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-04 (MW-DUP-01 Feb 2009-SE - Ground Water)						Sampled: 02/09/09				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-05 (MW-EB-01 Feb 2009-SE - Ground Water)						Sampled: 02/09/09 17:20				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 09/03/09 09:25

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSE0595-01 (SLMW01 May 2009 SE - Ground Water)						Sampled: 05/18/09 12:55				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-02 (SLMW02 May 2009 SE - Ground Water)						Sampled: 05/18/09 13:40				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-03 (SLMW03 May 2009 SE - Ground Water)						Sampled: 05/18/09 14:20				
Metals										
Lead	0.4	UB A	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-04 (MW Dup01 May 2009 SE - Ground Water)						Sampled: 05/18/09				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-05 (MW EB01 May 2009 SE - Ground Water)						Sampled: 05/18/09 14:45				
Metals										
Lead	0.18	J	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	0.19	J	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A

US Coast Guard Station Ludington

Data Review

LUDINGTON, MICHIGAN

Metals Analyses

SDGs# WSG0696 & WSG0776

Analyses Performed By:
TestAmerica Laboratories
Watertown, Wisconsin

Report: #10737R1
Review Level: Tier III
Project: DE000122.0002.00004

SUMMARY

This data quality assessment summarizes the review of Sample Delivery Groups (SDGs) #WSG0696 and WSG0776 for samples collected in association with the USCG Station Ludington site. The review was conducted as a Tier III evaluation and included review of data package completeness. Only analytical data associated with constituents of concern were reviewed for this validation. Field documentation was not included in this review. Included with this assessment are the validation annotated sample result sheets, and chain of custody. Analyses were performed on the following samples:

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis			
						VOC	SVOC	PCB	MET
WSG0696	SLWC010001 July 2009 Removed	WSG0696-01	Soil	7/21/2009					X
WSG0696	SLWC020001 July 2009 Removed	WSG0696-02	Soil	7/21/2009					X
WSG0776	SLRC 020004 July 2009 Removal (TS)	WSG0776-01	Soil	7/22/2009					X
WSG0776	SLRC 020004 July 2009 Removal (Calc)	WSG0776-02	Soil	7/22/2009					X
WSG0776	SLRC 020004 July 2009 Removal(Fine)	WSG0776-03	Soil	7/22/2009					X
WSG0776	SLRC 020004 July 2009 Removal (Coarse)	WSG0776-04	Soil	7/22/2009					X
WSG0776	SLRC 020005 July 2009 Removal (TS)	WSG0776-05	Soil	7/22/2009					X
WSG0776	SLRC 020005 July 2009 Removal (Calc)	WSG0776-06	Soil	7/22/2009					X
WSG0776	SLRC 020005 July 2009 Removal (Fine)	WSG0776-07	Soil	7/22/2009					X
WSG0776	SLRC 020005 July 2009 Removal (Coarse)	WSG0776-08	Soil	7/22/2009					X
WSG0776	SLRC 020006 July 2009 Removal (TS)	WSG0776-09	Soil	7/22/2009					X
WSG0776	SLRC 020006 July 2009 Removal (Calc)	WSG0776-10	Soil	7/22/2009					X
WSG0776	SLRC 020006 July 2009 Removal (Fine)	WSG0776-11	Soil	7/22/2009					X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis			
						VOC	SVOC	PCB	MET
WSG0776	SLRC 020006 July 2009 Removal (Coarse)	WSG0776-12	Soil	7/22/2009					X
WSG0776	SLDUP 020001 July 2009 Removal (TS)	WSG0776-13	Soil	7/22/2009					X
WSG0776	SLDUP 020001 July 2009 Removal(Calc)	WSG0776-14	Soil	7/22/2009					X
WSG0776	SLDUP 020001 July 2009 Removal(Fine)	WSG0776-15	Soil	7/22/2009					X
WSG0776	SLDUP 020001 July 2009 Removal (Coarse)	WSG0776-16	Soil	7/22/2009					X

Note:

1. Samples SLWC010001 July 2009 Removed and SLWC020001 July 2009 Removed were analyzed for TCLP metals.
2. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample location SLWC020001 July 2009 Removed.

ANALYTICAL DATA PACKAGE DOCUMENTATION

The table below is the evaluation of the data package completeness.

Items Reviewed	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
1. Sample receipt condition		X		X	
2. Requested analyses and sample results		X		X	
3. Master tracking list		X		X	
4. Methods of analysis		X		X	
5. Reporting limits		X		X	
6. Sample collection date		X		X	
7. Laboratory sample received date		X		X	
8. Sample preservation verification (as applicable)		X		X	
9. Sample preparation/extraction/analysis dates		X		X	
10. Fully executed Chain-of-Custody (COC) form		X		X	
11. Narrative summary of QA or sample problems provided		X		X	
12. Data Package Completeness and Compliance		X		X	

QA - Quality Assurance

INORGANIC ANALYSIS INTRODUCTION

Analyses were performed according to United States Environmental Protection Agency (USEPA) SW-846 Methods 1311, 6010B and 7470A. Data were reviewed in accordance with USEPA National Functional Guidelines of July 2002.

The data review process is an evaluation of data on a technical basis rather than a determination of contract compliance. As such, the standards against which the data are being weighed may differ from those specified in the analytical method. It is assumed that the data package represents the best efforts of the laboratory and that it was already subjected to adequate and sufficient quality review prior to submission.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results are qualified with the following codes in accordance with the USEPA National Functional Guidelines:

- Concentration (C) Qualifiers
 - U The analyte was analyzed for but not detected. The associated value is the analyte instrument detection limit.
 - B The reported value was obtained from a reading less than the contract-required detection limit (CRDL), but greater than or equal to the instrument detection limit (IDL).
- Quantitation (Q) Qualifiers
 - E The reported value is estimated due to the presence of interference.
 - N Spiked sample recovery is not within control limits.
 - * Duplicate analysis is not within control limits.
- Validation Qualifiers
 - J The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
 - UJ The analyte was not detected above the reported sample detection limit. However, the reported limit is approximate and may or may not represent the actual limit of detection.
 - UB Analyte considered non-detect at the listed value due to associated blank contamination.
 - R The sample results are rejected.

Two facts should be noted by all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant quality control (QC) problems, the analysis is invalid and provides no information as to whether the compound is present or not. "R" values should not appear on data tables because they cannot be relied upon, even as a last resort. The second fact to keep in mind is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data but any value potentially contains error.

METALS ANALYSES

1. Holding Times

The specified holding times for the following methods are presented in the following table.

Method	Matrix	Holding Time	Preservation
SW-846 6010B	Water	180 days from collection to analysis	Cooled @ 4 °C; preserved to a pH of less than 2.
	Soil	180 days from collection to analysis	Cooled @ 4 °C.
SW-846 1311/6010B	Soil	180 days from collection to leachate and 180 days from leachate to analysis	Cooled @ 4 °C.
SW-846 1311/7470	Soil	28 days from collection to leachate and 28 days from collection to analysis	Cooled @ 4 °C.

All samples were analyzed within the specified holding times.

2. Blank Contamination

Quality assurance (QA) blanks (i.e., method and rinse blanks) are prepared to identify any contamination which may have been introduced into the samples during sample preparation or field activity. Method blanks measure laboratory contamination. Rinse blanks measure contamination of samples during field operations.

A blank action level (BAL) of five times the concentration of a detected compound in an associated blank (common laboratory contaminant compounds are calculated at ten times) is calculated for QA blanks containing concentrations greater than the method detection limit (MDL). The BAL is compared to the associated sample results to determine the appropriate qualification of the sample results, if needed.

Analytes were not detected above the MDL in the associated blanks; therefore detected sample results were not associated with blank contamination.

3. Calibration

Satisfactory instrument calibration is established to provide that the instrument is capable of producing acceptable quantitative data. An initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of an experimental sequence. The continuing calibration verifies that the instrument's continuing performance is satisfactory.

3.1 Initial Calibration and Continuing Calibration

The correct number and type of standards were analyzed. The correlation coefficient of the initial calibration was greater than 0.995 for all non-ICP analytes and all initial calibration verification standard recoveries were within control limits.

All continuing calibration verification standard recoveries were within the control limit.

3.2 CRDL Check Standard

The CRDL check standard serves to verify the linearity of calibration of the analysis at the CRDL. The CRDL standard is not required for the analysis of aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), and potassium (K). The criteria used to evaluate the CRDL standard analysis are presented below in the CRDL standards evaluation table.

All CRDL standard recoveries were within control limits.

3.3 ICP Interference Control Sample (ICS)

The ICS verifies the laboratories interelement and background correction factors.

All ICS exhibited recoveries within the control limits.

4. Matrix Spike/Matrix Spike (MS/MSD) Analysis

MS/MSD data are used to assess the precision and accuracy of the analytical method.

4.1 MS/MSD Analysis

All metal analytes must exhibit a percent recovery within the established acceptance limits of 75% to 125%. The MS/MSD recovery control limits do not apply for MS/MSD performed on sample locations where the analyte's concentration detected in the parent sample exceeds the MS/MSD concentration by a factor of four or greater. In instance where this is true, the data will not be qualified even if the percent recovery does not meet the control limits and the laboratory qualifier "N" will be removed.

The MS/MSD analysis performed on sample locations SLWC-020001 July 2009 Removed exhibited recoveries within the control limits.

4.2 Laboratory Duplicate Analysis

The laboratory duplicate relative percent difference (RPD) criterion is applied when parent and duplicate sample concentrations are greater than or equal to 5 times the CRDL. A control limit of 20% for water matrices and 35% for soil matrices is applied when the criteria above is true. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the CRDL, a control limit of one times the CRDL is applied for water matrices and two times the CRDL for soil matrices.

MS/MSD analysis was performed in replacement of the laboratory duplicate analysis. The MS/MSD recoveries exhibited acceptable RPD.

5. Field Duplicate Analysis

Field duplicate analysis is used to assess the precision and accuracy of the field sampling procedures and analytical method. A control limit of 100% for soil matrices is applied to the RPD between the parent sample and the field duplicate. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the RL, a control limit of three times the RL is applied for soil matrices.

Results for duplicate samples are summarized in the following table.

Sample ID/Duplicate ID	Analyte	Sample Result	Duplicate Result	RPD
SLRC 020005 July 2009 Removal (Calc)/ SLDUP 020001 July 2009 Removal (Calc)	Lead	83	57	37.1%

Sample ID/Duplicate ID	Analyte	Sample Result	Duplicate Result	RPD
SLRC 020005 July 2009 Removal (Fine)/ SLDUP 020001 July 2009 Removal(Fine)	Lead	130	78	50.0%
SLRC 020005 July 2009 Removal (Coarse)/ SLDUP 020001 July 2009 Removal (Coarse)	Lead	53	44	18.6%

AC = Acceptable

The calculated RPDs between the parent sample and field duplicate were acceptable.

6. Laboratory Control Sample (LCS) Analysis

The LCS analysis is used to assess the precision and accuracy of the analytical method independent of matrix interferences. The analytes associated with the LCS analysis must exhibit a percent recovery between the control limits of 80% and 120%.

The LCS analysis exhibited recoveries within the control limits.

7. Serial Dilution

The serial dilution analysis is used to assess if a significant physical or chemical interference exists due to sample matrix. Analytes exhibiting concentrations greater than 50 times the MDL in the undiluted sample are evaluated to determine if matrix interference exists. These analytes are required to have less than a 10% difference (%D) between sample results from the undiluted (parent) sample and results associated with the same sample analyzed with a five-fold dilution.

The serial dilution performed on sample location SLRC 020005 July 2009 Removal (Fine) exhibited %D within the control limit.

8. System Performance and Overall Assessment

The laboratory flagged the TCLP metals results with T6. The laboratory used this flag to indicate that the ambient temperature where the agitation took place exceeded the method temperature criteria of $23 \pm 2^{\circ}\text{C}$. The ambient temperature should not affect the metal results, therefore, the laboratory qualifier was removed.

Overall system performance was acceptable. Other than for those deviations specifically mentioned in this review, the overall data quality is within the guidelines specified in the method.

DATA VALIDATION CHECKLIST FOR METAL

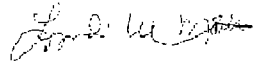
METALS; SW-846 6000/7000	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)					
Atomic Absorption – Manual Cold Vapor (CV)					
Tier II Validation					
Holding Times		X		X	
Reporting limits (units)		X		X	
Blanks					
A. Instrument Blanks					X
B. Method Blanks		X		X	
C. Equipment Blanks					X
Laboratory Control Sample (LCS)		X		X	
Matrix Spike (MS) %R		X		X	
Matrix Spike Duplicate (MSD) %R		X		X	
MS/MSD Precision (RPD)		X		X	
Field Duplicate (RPD)		X		X	
ICP Serial Dilution		X		X	
Reporting Limit Verification		X		X	
Raw Data					X
Tier III Validation					
Initial Calibration Verification		X		X	
Continuing Calibration Verification		X		X	
CRDL Standard		X		X	
ICP Interference Check		X		X	
Transcription/calculation errors present				X	
Reporting limits adjusted to reflect sample dilutions		X		X	

%R Percent recovery

RPD Relative percent difference

VALIDATION PERFORMED BY: Lyndi Mott

SIGNATURE:



DATE: September 9, 2009

REVISION DATE: November 25, 2009

PEER REVIEW: Dennis Capria

DATE: September 16, 2009

**CHAIN OF CUSTODY/
CORRECTED SAMPLE ANALYSIS DATA SHEETS**

WSG 0296

THE LEADER IN ENVIRONMENTAL TESTING

*Special Instructions/
Conditions of Receipt*

mp
lg 320. Glas
lg 320. Glas ja-

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

$R = 71.2210^\circ$

WS 60776

TAL-4142 (0408)

[illegible]

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Q 7123/09

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0696
Project: USCG Ludington
Project Number: D09-0066

Received: 07/22/09
Reported: 07/30/09 15:56

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0696-01 (SLWC010001 July 2009 Removed - Solid/Soil)						Sampled: 07/21/09 08:30			
TCLP Metals									
Arsenic	<0.36		mg/L	0.36	2	07/30/09 09:41	gaf	9070686	SW 6010B
Barium	0.95		mg/L	0.020	2	07/30/09 09:41	gaf	9070686	SW 6010B
Cadmium	<0.020		mg/L	0.020	2	07/30/09 09:41	gaf	9070686	SW 6010B
Chromium	<0.040		mg/L	0.040	2	07/30/09 09:41	gaf	9070686	SW 6010B
Lead	0.37		mg/L	0.20	2	07/30/09 09:41	gaf	9070686	SW 6010B
Mercury	<0.0010		mg/L	0.0010	1	07/28/09 15:58	mmm	9070666	SW 7470A
Selenium	<0.32		mg/L	0.32	2	07/30/09 09:41	gaf	9070686	SW 6010B
Silver	<0.040		mg/L	0.040	2	07/30/09 09:41	gaf	9070686	SW 6010B
Extraction	Yes	To	YesNo	NA	1	07/28/09 07:00	jej	9070658	SW 1311
Sample ID: WSG0696-02 (SLWC020001 July 2009 Removed - Solid/Soil)						Sampled: 07/21/09 09:20			
TCLP Metals									
Arsenic	<0.36		mg/L	0.36	2	07/30/09 09:45	gaf	9070686	SW 6010B
Barium	0.65		mg/L	0.020	2	07/30/09 09:45	gaf	9070686	SW 6010B
Cadmium	0.026		mg/L	0.020	2	07/30/09 09:45	gaf	9070686	SW 6010B
Chromium	<0.040		mg/L	0.040	2	07/30/09 09:45	gaf	9070686	SW 6010B
Lead	1.5		mg/L	0.20	2	07/30/09 09:45	gaf	9070686	SW 6010B
Mercury	<0.0010		mg/L	0.0010	1	07/28/09 15:58	mmm	9070666	SW 7470A
Selenium	<0.32		mg/L	0.32	2	07/30/09 09:45	gaf	9070686	SW 6010B
Silver	<0.040		mg/L	0.040	2	07/30/09 09:45	gaf	9070686	SW 6010B
Extraction	Yes	To	YesNo	NA	1	07/28/09 07:00	jej	9070658	SW 1311

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0776-01 (SLRC 020004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:26			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:14	LER	9070588	SW 5035
Sample ID: WSG0776-02 (SLRC 020004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	31		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-03 (SLRC 020004 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/22/09 10:26			
Metals									
Lead	47		mg/kg	1.2	1	07/29/09 08:37	gaf	9070671	SW 6010B
Sample ID: WSG0776-04 (SLRC 020004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:26			
Metals									
Lead	20		mg/kg	1.2	1	07/29/09 08:40	gaf	9070671	SW 6010B
Sample ID: WSG0776-05 (SLRC 020005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:34			
General Chemistry Parameters									
% Solids	97		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0776-06 (SLRC 020005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	83		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-07 (SLRC 020005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 08:44	gaf	9070671	SW 6010B
Sample ID: WSG0776-08 (SLRC 020005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	53		mg/kg	1.2	1	07/29/09 08:47	gaf	9070671	SW 6010B
Sample ID: WSG0776-09 (SLRC 020006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 11:34			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0776-10 (SLRC 020006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	91		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-11 (SLRC 020006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 08:51	gaf	9070671	SW 6010B
Sample ID: WSG0776-12 (SLRC 020006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	67		mg/kg	1.2	1	07/29/09 08:55	gaf	9070671	SW 6010B
Sample ID: WSG0776-13 (SLDUP 020001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
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Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0776-14 (SLDUP 020001 July 2009 Removal(Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	57		mg/kg	0.048	0.04	07/30/09 10:15	mmn	9070730	SW 6010B
Sample ID: WSG0776-15 (SLDUP 020001 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	78		mg/kg	1.2	1	07/29/09 08:58	gaf	9070671	SW 6010B
Sample ID: WSG0776-16 (SLDUP 020001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	44		mg/kg	1.2	1	07/29/09 09:02	gaf	9070671	SW 6010B

US Coast Guard Station Ludington

Data Review

LUDINGTON, MICHIGAN

Metals Analyses

SDGs# WSG0780 & WSG0822

Analyses Performed By:
TestAmerica Laboratories
Watertown, Wisconsin

Report: #10738R1
Review Level: Tier III
Project: DE000122.0002.00004

SUMMARY

This data quality assessment summarizes the review of Sample Delivery Groups (SDGs) #WSG0780 and WSG0822 for samples collected in association with the USCG Station Ludington site. The review was conducted as a Tier III evaluation and included review of data package completeness. Only analytical data associated with constituents of concern were reviewed for this validation. Field documentation was not included in this review. Included with this assessment are the validation annotated sample result sheets, and chain of custody. Analyses were performed on the following samples:

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0780	SLRC 010004 July 2009 Removal (TS)	WSG0780-01	Soil	7/21/2009				X
WSG0780	SLRC 010004 July 2009 Removal (Calc)	WSG0780-02	Soil	7/21/2009				X
WSG0780	SLRC 010004 July 2009 Removal (Fine)	WSG0780-03	Soil	7/21/2009				X
WSG0780	SLRC 010004 July 2009 Removal(Coarse)	WSG0780-04	Soil	7/21/2009				X
WSG0780	SLRC 010005 July 2009 Removal (TS)	WSG0780-05	Soil	7/21/2009				X
WSG0780	SLRC 010005 July 2009 Removal (Calc)	WSG0780-06	Soil	7/21/2009				X
WSG0780	SLRC 010005 July 2009 Removal (Fine)	WSG0780-07	Soil	7/21/2009				X
WSG0780	SLRC 010005 July 2009 Removal(Coarse)	WSG0780-08	Soil	7/21/2009				X
WSG0780	SLRC 010006 July 2009 Removal (TS)	WSG0780-09	Soil	7/21/2009				X
WSG0780	SLRC 010006 July 2009 Removal (Calc)	WSG0780-10	Soil	7/21/2009				X
WSG0780	SLRC 010006 July 2009 Removal(Fine)	WSG0780-11	Soil	7/21/2009				X
WSG0780	SLRC 010006 July 2009 Removal(Coarse)	WSG0780-12	Soil	7/21/2009				X
WSG0780	SLRC 010007 July 2009 Removal (TS)	WSG0780-13	Soil	7/21/2009				X
WSG0780	SLRC 010007 July 2009 Removal (Calc)	WSG0780-14	Soil	7/21/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0780	SLRC 010007 July 2009 Removal (Fine)	WSG0780-15	Soil	7/21/2009				X
WSG0780	SLRC 010007 July 2009 Removal (Coarse)	WSG0780-16	Soil	7/21/2009				X
WSG0780	SLRC 010012 July 2009 Removal (TS)	WSG0780-17	Soil	7/22/2009				X
WSG0780	SLRC 010012 July 2009 Removal (Calc)	WSG0780-18	Soil	7/22/2009				X
WSG0780	SLRC 010012 July 2009 Removal (Fine)	WSG0780-19	Soil	7/22/2009				X
WSG0780	SLRC 010012 July 2009 Removal (Coarse)	WSG0780-20	Soil	7/22/2009				X
WSG0780	SLEB 010001 July 2009 Removal	WSG0780-21	Water	7/22/2009				X
WSG0780	SLRC 020001 July 2009 Removal (TS)	WSG0780-22	Soil	7/22/2009				X
WSG0780	SLRC 020001 July 2009 Removal (Calc)	WSG0780-23	Soil	7/22/2009				X
WSG0780	SLRC 020001 July 2009 Removal (Fine)	WSG0780-24	Soil	7/22/2009				X
WSG0780	SLRC 020001 July 2009 Removal (Coarse)	WSG0780-25	Soil	7/22/2009				X
WSG0780	SLRC 020002 July 2009 Removal (TS)	WSG0780-26	Soil	7/22/2009				X
WSG0780	SLRC 020002 July 2009 Removal (Calc)	WSG0780-27	Soil	7/22/2009				X
WSG0780	SLRC 020002 July 2009 Removal (Fine)	WSG0780-28	Soil	7/22/2009				X
WSG0780	SLRC 020002 July 2009 Removal (Coarse)	WSG0780-29	Soil	7/22/2009				X
WSG0822	SLRC 050007 July 2009 Removal (TS)	WSG0822-01	Soil	7/23/2009				X
WSG0822	SLRC 050007 July 2009 Removal (Calc)	WSG0822-02	Soil	7/23/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0822	SLRC 050007 July 2009 Removal (Fine)	WSG0822-03	Soil	7/23/2009				X
WSG0822	SLRC 050007 July 2009 Removal (Coarse)	WSG0822-04	Soil	7/23/2009				X
WSG0822	SLEB 030003 July 2009 Removal	WSG0822-05	Water	7/23/2009				X
WSG0822	SLRC 030006 July 2009 Removal (TS)	WSG0822-06	Soil	7/23/2009				X
WSG0822	SLRC 030006 July 2009 Removal (Calc)	WSG0822-07	Soil	7/23/2009				X
WSG0822	SLRC 030006 July 2009 Removal (Fine)	WSG0822-08	Soil	7/23/2009				X
WSG0822	SLRC 030006 July 2009 Removal (Coarse)	WSG0822-09	Soil	7/23/2009				X
WSG0822	SLRC 030001 July 2009 Removal (TS)	WSG0822-10	Soil	7/23/2009				X
WSG0822	SLRC 030001 July 2009 Removal (Calc)	WSG0822-11	Soil	7/23/2009				X
WSG0822	SLRC 030001 July 2009 Removal (Fine)	WSG0822-12	Soil	7/23/2009				X
WSG0822	SLRC 030001 July 2009 Removal (Coarse)	WSG0822-13	Soil	7/23/2009				X
WSG0822	SLRC 030004 July 2009 Removal (TS)	WSG0822-14	Soil	7/23/2009				X
WSG0822	SLRC 030004 July 2009 Removal (Calc)	WSG0822-15	Soil	7/23/2009				X
WSG0822	SLRC 030004 July 2009 Removal (Fine)	WSG0822-16	Soil	7/23/2009				X
WSG0822	SLRC 030004 July 2009 Removal (Coarse)	WSG0822-17	Soil	7/23/2009				X
WSG0822	SLDUP 030003 July 2009 Removal (TS)	WSG0822-18	Soil	7/23/2009				X
WSG0822	SLDUP 030003 July 2009 Removal (Calc)	WSG0822-19	Soil	7/23/2009	SLRC 030002 July 2009 Removal (Calc)			X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0822	SLDUP 030003 July 2009 Removal (Fine)	WSG0822-20	Soil	7/23/2009	SLRC 030002 July 2009 Removal (Fine)			X
WSG0822	SLDUP 030003 July 2009 Removal(Coarse)	WSG0822-21	Soil	7/23/2009	SLRC 030002 July 2009 Removal (Coarse)			X
WSG0822	SLRC 030005 July 2009 Removal (TS)	WSG0822-22	Soil	7/23/2009				X
WSG0822	SLRC 030005 July 2009 Removal (Calc)	WSG0822-23	Soil	7/23/2009				X
WSG0822	SLRC 030005 July 2009 Removal (Fine)	WSG0822-24	Soil	7/23/2009				X
WSG0822	SLRC 030005 July 2009 Removal(Coarse)	WSG0822-25	Soil	7/23/2009				X
WSG0822	SLRC 030002 July 2009 Removal (TS)	WSG0822-26	Soil	7/23/2009				X
WSG0822	SLRC 030002 July 2009 Removal (Calc)	WSG0822-27	Soil	7/23/2009				X
WSG0822	SLRC 030002 July 2009 Removal (Fine)	WSG0822-28	Soil	7/23/2009				X
WSG0822	SLRC 030002 July 2009 Removal(Coarse)	WSG0822-29	Soil	7/23/2009				X
WSG0822	SLRC 030003 July 2009 Removal (TS)	WSG0822-30	Soil	7/23/2009				X
WSG0822	SLRC 030003 July 2009 Removal (Calc)	WSG0822-31	Soil	7/23/2009				X
WSG0822	SLRC 030003 July 2009 Removal (Fine)	WSG0822-32	Soil	7/23/2009				X
WSG0822	SLRC 030003 July 2009 Removal(Coarse)	WSG0822-33	Soil	7/23/2009				X

Note:

1. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample locations SLRC 010012 July 2009 Removal (Fine) and SLRC 010012 July 2009 Removal (Coarse).
2. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample locations SLRC 030005 July 2009 Removal (Fine) and SLRC 030005 July 2009 Removal (Coarse).

ANALYTICAL DATA PACKAGE DOCUMENTATION

The table below is the evaluation of the data package completeness.

Items Reviewed	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
1. Sample receipt condition		X		X	
2. Requested analyses and sample results		X		X	
3. Master tracking list		X		X	
4. Methods of analysis		X		X	
5. Reporting limits		X		X	
6. Sample collection date		X		X	
7. Laboratory sample received date		X		X	
8. Sample preservation verification (as applicable)		X		X	
9. Sample preparation/extraction/analysis dates		X		X	
10. Fully executed Chain-of-Custody (COC) form		X		X	
11. Narrative summary of QA or sample problems provided		X		X	
12. Data Package Completeness and Compliance		X		X	

QA - Quality Assurance

INORGANIC ANALYSIS INTRODUCTION

Analyses were performed according to United States Environmental Protection Agency (USEPA) SW-846 Method 6010B. Data were reviewed in accordance with USEPA National Functional Guidelines of July 2002.

The data review process is an evaluation of data on a technical basis rather than a determination of contract compliance. As such, the standards against which the data are being weighed may differ from those specified in the analytical method. It is assumed that the data package represents the best efforts of the laboratory and that it was already subjected to adequate and sufficient quality review prior to submission.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results are qualified with the following codes in accordance with the USEPA National Functional Guidelines:

- Concentration (C) Qualifiers
 - U The analyte was analyzed for but not detected. The associated value is the analyte instrument detection limit.
 - B The reported value was obtained from a reading less than the contract-required detection limit (CRDL), but greater than or equal to the instrument detection limit (IDL).
- Quantitation (Q) Qualifiers
 - E The reported value is estimated due to the presence of interference.
 - N Spiked sample recovery is not within control limits.
 - * Duplicate analysis is not within control limits.
- Validation Qualifiers
 - J The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
 - UJ The analyte was not detected above the reported sample detection limit. However, the reported limit is approximate and may or may not represent the actual limit of detection.
 - UB Analyte considered non-detect at the listed value due to associated blank contamination.
 - R The sample results are rejected.

Two facts should be noted by all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant quality control (QC) problems, the analysis is invalid and provides no information as to whether the compound is present or not. "R" values should not appear on data tables because they cannot be relied upon, even as a last resort. The second fact to keep in mind is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data but any value potentially contains error.

METALS ANALYSES

1. Holding Times

The specified holding times for the following methods are presented in the following table.

Method	Matrix	Holding Time	Preservation
SW-846 6010B	Water	180 days from collection to analysis	Cooled @ 4 °C; preserved to a pH of less than 2.
	Soil	180 days from collection to analysis	Cooled @ 4 °C.

All samples were analyzed within the specified holding times.

2. Blank Contamination

Quality assurance (QA) blanks (i.e., method and rinse blanks) are prepared to identify any contamination which may have been introduced into the samples during sample preparation or field activity. Method blanks measure laboratory contamination. Rinse blanks measure contamination of samples during field operations.

A blank action level (BAL) of five times the concentration of a detected compound in an associated blank (common laboratory contaminant compounds are calculated at ten times) is calculated for QA blanks containing concentrations greater than the method detection limit (MDL). The BAL is compared to the associated sample results to determine the appropriate qualification of the sample results, if needed.

Analytes were detected in the associated QA blanks; however, the associated sample results were greater than the BAL. No other qualification of the sample results was required.

3. Calibration

Satisfactory instrument calibration is established to provide that the instrument is capable of producing acceptable quantitative data. An initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of an experimental sequence. The continuing calibration verifies that the instrument's continuing performance is satisfactory.

3.1 Initial Calibration and Continuing Calibration

The correct number and type of standards were analyzed. The correlation coefficient of the initial calibration was greater than 0.995 for all non-ICP analytes and all initial calibration verification standard recoveries were within control limits.

All continuing calibration verification standard recoveries were within the control limit.

3.2 CRDL Check Standard

The CRDL check standard serves to verify the linearity of calibration of the analysis at the CRDL. The CRDL standard is not required for the analysis of aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), and potassium (K). The criteria used to evaluate the CRDL standard analysis are presented below in the CRDL standards evaluation table.

All CRDL standard recoveries were within control limits.

3.3 ICP Interference Control Sample (ICS)

The ICS verifies the laboratories interelement and background correction factors.

All ICS exhibited recoveries within the control limits.

4. Matrix Spike/Matrix Spike (MS/MSD) Analysis

MS/MSD data are used to assess the precision and accuracy of the analytical method.

4.1 MS/MSD Analysis

All metal analytes must exhibit a percent recovery within the established acceptance limits of 75% to 125%. The MS/MSD recovery control limits do not apply for MS/MSD performed on sample locations where the analyte's concentration detected in the parent sample exceeds the MS/MSD concentration by a factor of four or greater. In instance where this is true, the data will not be qualified even if the percent recovery does not meet the control limits and the laboratory qualifier "N" will be removed.

The MS/MSD analysis performed on sample locations SLRC 010012 July 2009 Removal (Fine), SLRC 010012 July 2009 Removal (Coarse), SLRC 030005 July 2009 Removal (Fine) and SLRC 030005 July 2009 Removal (Coarse) exhibited recoveries within the control limits.

4.2 Laboratory Duplicate Analysis

The laboratory duplicate relative percent difference (RPD) criterion is applied when parent and duplicate sample concentrations are greater than or equal to 5 times the CRDL. A control limit of 20% for water matrices and 35% for soil matrices is applied when the criteria above is true. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the CRDL, a control limit of one times the CRDL is applied for water matrices and two times the CRDL for soil matrices.

MS/MSD analysis was performed in replacement of the laboratory duplicate analysis. The MS/MSD recoveries exhibited acceptable RPD.

5. Field Duplicate Analysis

Field duplicate analysis is used to assess the precision and accuracy of the field sampling procedures and analytical method. A control limit of 100% for soil matrices is applied to the RPD between the parent sample and the field duplicate. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the RL, a control limit of three times the RL is applied for soil matrices.

Results for duplicate samples are summarized in the following table.

Sample ID/Duplicate ID	Analyte	Sample Result	Duplicate Result	RPD
SLRC 030002 July 2009 Removal (Calc)/ SLDUP 030003 July 2009 Removal (Calc)	Lead	200	120	50.0%
SLRC 030002 July 2009 Removal (Fine)/ SLDUP 030003 July 2009 Removal (Fine)	Lead	250	130	63.2%
SLRC 030002 July 2009 Removal (Coarse)/ SLDUP 030003 July 2009 Removal (Coarse)	Lead	68	120	55.3%

AC = Acceptable

The calculated RPDs between the parent sample and field duplicate were acceptable.

6. Laboratory Control Sample (LCS) Analysis

The LCS analysis is used to assess the precision and accuracy of the analytical method independent of matrix interferences. The analytes associated with the LCS analysis must exhibit a percent recovery between the control limits of 80% and 120%.

The LCS analysis exhibited recoveries within the control limits.

7. Serial Dilution

The serial dilution analysis is used to assess if a significant physical or chemical interference exists due to sample matrix. Analytes exhibiting concentrations greater than 50 times the MDL in the undiluted sample are evaluated to determine if matrix interference exists. These analytes are required to have less than a 10% difference (%D) between sample results from the undiluted (parent) sample and results associated with the same sample analyzed with a five-fold dilution.

The serial dilution performed on sample location SLRC 030006 July 2009 Removal (Fine) exhibited %D within the control limit.

8. System Performance and Overall Assessment

Overall system performance was acceptable. Other than for those deviations specifically mentioned in this review, the overall data quality is within the guidelines specified in the method.

DATA VALIDATION CHECKLIST FOR METAL

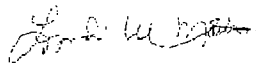
METALS: SW-846 6000	Reported		Performance Acceptable		Not Required	
	No	Yes	No	Yes		
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)						
Tier II Validation						
Holding Times		X		X		
Reporting limits (units)		X		X		
Blanks						
A. Instrument Blanks					X	
B. Method Blanks		X		X		
C. Equipment Blanks		X	X			
Laboratory Control Sample (LCS)		X		X		
Matrix Spike (MS) %R		X		X		
Matrix Spike Duplicate (MSD) %R		X		X		
MS/MSD Precision (RPD)		X		X		
Field Duplicate (RPD)		X		X		
ICP Serial Dilution		X		X		
Reporting Limit Verification		X		X		
Raw Data					X	
Tier III Validation						
Initial Calibration Verification		X		X		
Continuing Calibration Verification		X		X		
CRDL Standard		X		X		
ICP Interference Check		X		X		
Transcription/calculation errors present				X		
Reporting limits adjusted to reflect sample dilutions		X		X		

%R Percent recovery

RPD Relative percent difference

VALIDATION PERFORMED BY: Lyndi Mott

SIGNATURE:



DATE: September 10, 2009

REVISION DATE: November 25, 2009

PEER REVIEW: Dennis Capria

DATE: September 16, 2009

**CHAIN OF CUSTODY/
CORRECTED SAMPLE ANALYSIS DATA SHEETS**

Chain of Custody Record

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

WS 60780

TAL-4142 (0408)

Client <u>Arcadis</u>		Project Manager <u>Mark Kittinger</u>		Date <u>7/22/09</u>	Chain of Custody Number <u>017606</u>
Address <u>28550 Cabot Dr Suite 500</u>		Telephone Number (Area Code)/Fax Number <u>248-994-2288</u>		Lab Number <u>WT</u>	Page <u>1</u> of <u>1</u>

City <u>Novi</u>	State <u>MI</u>	Zip Code <u>48377</u>	Site Contact <u>T. Stefan</u>	Lab Contact <u>W. Topel</u>	Analysis (Attach list if more space is needed)
Project Name and Location (State) <u>US Coast Guard 010 Station Lubington</u>			Carrier/Waybill Number		

Contract/Purchase Order/Quote No. <u>109-0066</u>	Matrix	Containers & Preservatives	Special Instructions/Conditions of Receipt
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Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	H2O2	ZnCl2	NaOH	Lead f/c	T-lead
01-04 SLR010004-July 2009 Removal	7/21/09	1544				1	1								
05-08 SLR010005-July 2009 Removal	7/21/09	1547				1	1								
09-12 SLR010006-July 2009 Removal	7/21/09	1558				1	1								
13-16 SLR010007-July 2009 Removal	7/21/09	1604				1	1								
17-20 SLR010012-July 2009 Removal	7/22/09	858				1	1								
21 SLR010001-July 2009 Removal	7/22/09	952		1					1					1	
22-25 SLR020001-July 2009 Removal	7/22/09	1007				1	1							1	
26-29 SLR020002-July 2009 Removal	7/22/09	1014				1	1							1	

Possible Hazard Identification	Sample Disposal	(A fee may be assessed if samples are retained longer than 1 month)
<input checked="" type="checkbox"/> Non-Hazard <input type="checkbox"/> Flammable <input type="checkbox"/> Skin Irritant <input type="checkbox"/> Poison B <input type="checkbox"/> Unknown	<input type="checkbox"/> Return To Client <input checked="" type="checkbox"/> Disposal By Lab <input type="checkbox"/> Archive For _____ Months	

Turn Around Time Required		QC Requirements (Specify)	
<input type="checkbox"/> 24 Hours <input type="checkbox"/> 48 Hours <input type="checkbox"/> 7 Days <input type="checkbox"/> 14 Days <input type="checkbox"/> 21 Days <input checked="" type="checkbox"/> Other <u>5 Day</u>		<u>Level III</u>	
1. Relinquished By <u>[Signature]</u>	Date <u>7/22/09</u>	Time <u>1507</u>	1. Received By <u>[Signature]</u>
2. Relinquished By	Date	Time	2. Received By
3. Relinquished By	Date	Time	3. Received By

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

2 7/23/09

WSG0822

THE LEADER IN ENVIRONMENTAL TESTING

Client Arcadis		Project Manager Mark Kittinger		Date 7-23-2009		Chain of Custody Number 017612	
Address 28550 Cabot Dr Suite 500		Telephone Number (Area Code)/Fax Number 248-444-2288		Lab Number NA		Page 1 of 1	
City Novi	State MI	Zip Code 48377	Site Contact T Schafani	Lab Contact W Topel	Analysis (Attach list if more space is needed)		
Project Name and Location (State) US Coast Guard Old Station Ludington			Carrier/Waybill Number 8681 4831 3910				
Contract/Purchase Order/Quote No. A09-0066			Matrix	Containers & Preservatives	Special Instructions/ Conditions of Receipt		

Sample I.D. No. and Description
(Containers for each sample may be combined on one line)

-01-04	SLRC050007-July 2009 Removal	7-23-09	1145		1	1		1	
-05	SLEB030003-July 2009 Removal	7-23-09	1230	1			1	(X) 1	
-06-09	SLRC030006-July 2009 Removal	7/23/09	1300		1	1		1	
-10-13	SLRC030001-July 2009 Removal	7/23/09	1235		1	1		1	
14-17	SLRC030004-July 2009 Removal	7/23/09	1250		1	1		1	
18-21	SL0up 030003-July 2009 Removal	7/23/09	—		1	1		1	
22-25	SLRC030005-July 2009 Removal	7/23/09	1255		3/1	3/1		3/1	ms/MSD
26-29	SLRC030002-July 2009 Removal	7/23/09	1240		1	1		1	
30-33	SLRC030003-July 2009 Removal	7/23/09	1245		1	1		1	

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Return To Client

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other 5 Day

7/23/09 15th

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
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[illegible]

Level III

Mydott 7/34/19 1.17)

[illegible][illegible]

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Q 7/24/09

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sciafani

Work Order: WSG0780
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:29

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-01 (SLRC 010004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:44			
General Chemistry Parameters									
% Solids	100		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-02 (SLRC 010004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	22		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-03 (SLRC 010004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	26		mg/kg	1.2	1	07/29/09 09:16	gaf	9070671	SW 6010B
Sample ID: WSG0780-04 (SLRC 010004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	14		mg/kg	1.2	1	07/29/09 09:20	gaf	9070671	SW 6010B
Sample ID: WSG0780-05 (SLRC 010005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:47			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-06 (SLRC 010005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	59		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-07 (SLRC 010005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	47		mg/kg	1.2	1	07/29/09 09:23	gaf	9070671	SW 6010B
Sample ID: WSG0780-08 (SLRC 010005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	66		mg/kg	1.2	1	07/29/09 09:27	gaf	9070671	SW 6010B
Sample ID: WSG0780-09 (SLRC 010006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:58			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-10 (SLRC 010006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	240		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-11 (SLRC 010006 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	310		mg/kg	1.2	1	07/29/09 09:30	gaf	9070671	SW 6010B
Sample ID: WSG0780-12 (SLRC 010006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	170		mg/kg	1.2	1	07/29/09 09:34	gaf	9070671	SW 6010B
Sample ID: WSG0780-13 (SLRC 010007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 16:04			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-14 (SLRC 010007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	45		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-15 (SLRC 010007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	49		mg/kg	1.2	1	07/29/09 09:37	gaf	9070671	SW 6010B
Sample ID: WSG0780-16 (SLRC 010007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	43		mg/kg	1.2	1	07/29/09 09:41	gaf	9070671	SW 6010B
Sample ID: WSG0780-17 (SLRC 010012 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 08:55			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-18 (SLRC 010012 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	63		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-19 (SLRC 010012 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	79		mg/kg	1.2	1	07/29/09 09:44	gaf	9070671	SW 6010B
Sample ID: WSG0780-20 (SLRC 010012 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	42		mg/kg	1.2	1	07/29/09 10:06	gaf	9070671	SW 6010B

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Received: 07/23/09
Reported: 07/30/09 13:29

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-21 (SLEB 010001 July 2009 Removal - Water - NonPotable)							Sampled: 07/22/09 09:50			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	07/29/09 14:02	gaf	9070624	SW 6020A

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Reported: 07/30/09 13:29

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-22 (SLRC 020001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:07			
General Chemistry Parameters									
% Solids	96		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-23 (SLRC 020001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	35		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-24 (SLRC 020001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	54		mg/kg	1.2	1	07/29/09 10:17	gaf	9070671	SW 6010B
Sample ID: WSG0780-25 (SLRC 020001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	23		mg/kg	1.2	1	07/29/09 10:20	gaf	9070671	SW 6010B
Sample ID: WSG0780-26 (SLRC 020002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:14			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-27 (SLRC 020002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	13		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-28 (SLRC 020002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	17		mg/kg	1.2	1	07/29/09 10:45	gaf	9070672	SW 6010B
Sample ID: WSG0780-29 (SLRC 020002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	11		mg/kg	1.2	1	07/29/09 10:48	gaf	9070672	SW 6010B

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Work Order: WSG0822
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-01 (SLRC 050007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:45			
General Chemistry Parameters									
% Solids	94		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-02 (SLRC 050007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	190		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-03 (SLRC 050007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	200		mg/kg	1.2	1	07/29/09 11:03	gaf	9070672	SW 6010B
Sample ID: WSG0822-04 (SLRC 050007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 11:06	gaf	9070672	SW 6010B

ARCADIS - MICHIGAN
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Received: 07/24/09
Reported: 07/30/09 14:31

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-05 (SLEB 030003 July 2009 Removal - Water - NonPotable)							Sampled: 07/23/09 12:30			
Metals										
Lead	0.43		ug/L	0.12	0.40	1	07/28/09 12:51	gaf	9070628	SW 6020A

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
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Work Order: WSG0822
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Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-06 (SLRC 030006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 13:00			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-07 (SLRC 030006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	94		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-08 (SLRC 030006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	150		mg/kg	1.2	1	07/29/09 11:10	gaf	9070672	SW 6010B
Sample ID: WSG0822-09 (SLRC 030006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	36		mg/kg	1.2	1	07/29/09 11:14	gaf	9070672	SW 6010B
Sample ID: WSG0822-10 (SLRC 030001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:35			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-11 (SLRC 030001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	26		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-12 (SLRC 030001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	35		mg/kg	1.2	1	07/29/09 11:17	gaf	9070672	SW 6010B
Sample ID: WSG0822-13 (SLRC 030001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	13		mg/kg	1.2	1	07/29/09 11:21	gaf	9070672	SW 6010B
Sample ID: WSG0822-14 (SLRC 030004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:50			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-15 (SLRC 030004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	110		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-16 (SLRC 030004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 11:25	gaf	9070672	SW 6010B
Sample ID: WSG0822-17 (SLRC 030004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	74		mg/kg	1.2	1	07/29/09 11:29	gaf	9070672	SW 6010B
Sample ID: WSG0822-18 (SLDUP 030003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0822
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-19 (SLDUP 030003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	120		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-20 (SLDUP 030003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 11:32	gaf	9070672	SW 6010B
Sample ID: WSG0822-21 (SLDUP 030003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	120		mg/kg	1.2	1	07/29/09 11:36	gaf	9070672	SW 6010B
Sample ID: WSG0822-22 (SLRC 030005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:55			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-23 (SLRC 030005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	18		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-24 (SLRC 030005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	24		mg/kg	1.2	1	07/29/09 11:54	gaf	9070672	SW 6010B
Sample ID: WSG0822-25 (SLRC 030005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	13		mg/kg	1.2	1	07/29/09 12:04	gaf	9070672	SW 6010B
Sample ID: WSG0822-26 (SLRC 030002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:40			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-27 (SLRC 030002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	200		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-28 (SLRC 030002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	250		mg/kg	1.2	1	07/29/09 12:15	gaf	9070672	SW 6010B
Sample ID: WSG0822-29 (SLRC 030002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	68		mg/kg	1.2	1	07/29/09 12:19	gaf	9070672	SW 6010B
Sample ID: WSG0822-30 (SLRC 030003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:45			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-31 (SLRC 030003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
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Mr. Troy Sclafani

Work Order: WSG0822
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-32 (SLRC 030003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	1.2	1	07/29/09 13:25	gaf	9070688	SW 6010B
Sample ID: WSG0822-33 (SLRC 030003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	1.2	1	07/29/09 13:29	gaf	9070688	SW 6010B

US Coast Guard Station Ludington

Data Review

LUDINGTON, MICHIGAN

Metals Analyses

SDGs# WSG0826 & WSG0827

Analyses Performed By:
TestAmerica Laboratories
Watertown, Wisconsin

Report: #10739R1
Review Level: Tier III
Project: DE000122.0002.00004

SUMMARY

This data quality assessment summarizes the review of Sample Delivery Groups (SDGs) #WSG0826 and WSG0827 for samples collected in association with the USCG Station Ludington site. The review was conducted as a Tier III evaluation and included review of data package completeness. Only analytical data associated with constituents of concern were reviewed for this validation. Field documentation was not included in this review. Included with this assessment are the validation annotated sample result sheets, and chain of custody. Analyses were performed on the following samples:

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0826	SLEB 020002 July 2009 Removal	WSG0826-01	Water	7/22/2009				X
WSG0826	SLRC 040001 July 2009 Removal (TS)	WSG0826-02	Soil	7/22/2009				X
WSG0826	SLRC 040001 July 2009 Removal (Calc)	WSG0826-03	Soil	7/22/2009				X
WSG0826	SLRC 040001 July 2009 Removal (Fine)	WSG0826-04	Soil	7/22/2009				X
WSG0826	SLRC 040001 July 2009 Removal(Coarse)	WSG0826-05	Soil	7/22/2009				X
WSG0826	SLRC 040002 July 2009 Removal (TS)	WSG0826-06	Soil	7/22/2009				X
WSG0826	SLRC 040002 July 2009 Removal (Calc)	WSG0826-07	Soil	7/22/2009				X
WSG0826	SLRC 040002 July 2009 Removal (Fine)	WSG0826-08	Soil	7/22/2009				X
WSG0826	SLRC 040002 July 2009 Removal(Coarse)	WSG0826-09	Soil	7/22/2009				X
WSG0826	SLRC 040004 July 2009 Removal (TS)	WSG0826-10	Soil	7/22/2009				X
WSG0826	SLRC 040004 July 2009 Removal (Calc)	WSG0826-11	Soil	7/22/2009				X
WSG0826	SLRC 040004 July 2009 Removal (Fine)	WSG0826-12	Soil	7/22/2009				X
WSG0826	SLRC 040004 July 2009 Removal(Coarse)	WSG0826-13	Soil	7/22/2009				X
WSG0826	SLRC 040005 July 2009 Removal (TS)	WSG0826-14	Soil	7/22/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0826	SLRC 040005 July 2009 Removal (Calc)	WSG0826-15	Soil	7/22/2009				X
WSG0826	SLRC 040005 July 2009 Removal (Fine)	WSG0826-16	Soil	7/22/2009				X
WSG0826	SLRC 040005 July 2009 Removal(Coarse)	WSG0826-17	Soil	7/22/2009				X
WSG0826	SLRC 040006 July 2009 Removal (TS)	WSG0826-18	Soil	7/22/2009				X
WSG0826	SLRC 040006 July 2009 Removal (Calc)	WSG0826-19	Soil	7/22/2009				X
WSG0826	SLRC 040006 July 2009 Removal (Fine)	WSG0826-20	Soil	7/22/2009				X
WSG0826	SLRC 040006 July 2009 Removal(Coarse)	WSG0826-21	Water	7/22/2009				X
WSG0826	SLRC 040007 July 2009 Removal (TS)	WSG0826-22	Soil	7/22/2009				X
WSG0826	SLRC 040007 July 2009 Removal (Calc)	WSG0826-23	Soil	7/22/2009				X
WSG0826	SLRC 040007 July 2009 Removal (Fine)	WSG0826-24	Soil	7/22/2009				X
WSG0826	SLRC 040007 July 2009 Removal(Coarse)	WSG0826-25	Soil	7/22/2009				X
WSG0826	SLDUP 040002 July 2009 Removal (TS)	WSG0826-26	Soil	7/22/2009	SLRC 040007 July 2009 Removal (TS)			X
WSG0826	SLDUP 040002 July 2009 Removal (Calc)	WSG0826-27	Soil	7/22/2009	SLRC 040007 July 2009 Removal (Calc)			X
WSG0826	SLDUP 040002 July 2009 Removal (Fine)	WSG0826-28	Soil	7/22/2009	SLRC 040007 July 2009 Removal (Fine)			X
WSG0826	SLDUP 040002 July 2009 Removal(Coarse)	WSG0826-29	Soil	7/22/2009	SLRC 040007 July 2009 Removal (Coarse)			X
WSG0826	SLRC 040008 July 2009 Removal (TS)	WSG0826-30	Soil	7/22/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0826	SLRC 040008 July 2009 Removal (Calc)	WSG0826-31	Soil	7/22/2009				X
WSG0826	SLRC 040008 July 2009 Removal (Fine)	WSG0826-32	Soil	7/22/2009				X
WSG0826	SLRC 040008 July 2009 Removal (Coarse)	WSG0826-33	Soil	7/22/2009				X
WSG0827	SLRC 040010 July 2009 Removal (TS)	WSG0827-01	Soil	7/23/2009				X
WSG0827	SLRC 040010 July 2009 Removal (Calc)	WSG0827-02	Soil	7/23/2009				X
WSG0827	SLRC 040010 July 2009 Removal (Fine)	WSG0827-03	Soil	7/23/2009				X
WSG0827	SLRC 040010 July 2009 Removal (Coarse)	WSG0827-04	Soil	7/23/2009				X
WSG0827	SLRC 040011 July 2009 Removal (TS)	WSG0827-05	Soil	7/23/2009				X
WSG0827	SLRC 040011 July 2009 Removal (Calc)	WSG0827-06	Soil	7/23/2009				X
WSG0827	SLRC 040011 July 2009 Removal (Fine)	WSG0827-07	Soil	7/23/2009				X
WSG0827	SLRC 040011 July 2009 Removal (Coarse)	WSG0827-08	Soil	7/23/2009				X
WSG0827	SLRC 050001 July 2009 Removal (TS)	WSG0827-09	Soil	7/23/2009				X
WSG0827	SLRC 050001 July 2009 Removal (Calc)	WSG0827-10	Soil	7/23/2009				X
WSG0827	SLRC 050001 July 2009 Removal (Fine)	WSG0827-11	Soil	7/23/2009				X
WSG0827	SLRC 050001 July 2009 Removal (Coarse)	WSG0827-12	Soil	7/23/2009				X
WSG0827	SLRC 050002 July 2009 Removal (TS)	WSG0827-13	Soil	7/23/2009				X
WSG0827	SLRC 050002 July 2009 Removal (Calc)	WSG0827-14	Soil	7/23/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0827	SLRC 050002 July 2009 Removal (Fine)	WSG0827-15	Soil	7/23/2009				X
WSG0827	SLRC 050002 July 2009 Removal(Coarse)	WSG0827-16	Soil	7/23/2009				X
WSG0827	SLRC 050003 July 2009 Removal (TS)	WSG0827-17	Soil	7/23/2009				X
WSG0827	SLRC 050003 July 2009 Removal (Calc)	WSG0827-18	Soil	7/23/2009				X
WSG0827	SLRC 050003 July 2009 Removal (Fine)	WSG0827-19	Soil	7/23/2009				X
WSG0827	SLRC 050003 July 2009 Removal(Coarse)	WSG0827-20	Soil	7/23/2009				X
WSG0827	SLRC 050004 July 2009 Removal (TS)	WSG0827-21	Soil	7/23/2009				X
WSG0827	SLRC 050004 July 2009 Removal (Calc)	WSG0827-22	Soil	7/23/2009				X
WSG0827	SLRC 050004 July 2009 Removal (Fine)	WSG0827-23	Soil	7/23/2009				X
WSG0827	SLRC 050004 July 2009 Removal(Coarse)	WSG0827-24	Soil	7/23/2009				X
WSG0827	SLRC 050005 July 2009 Removal (TS)	WSG0827-25	Soil	7/23/2009				X
WSG0827	SLRC 050005 July 2009 Removal (Calc)	WSG0827-26	Soil	7/23/2009				X
WSG0827	SLRC 050005 July 2009 Removal (Fine)	WSG0827-27	Soil	7/23/2009				X
WSG0827	SLRC 050005 July 2009 Removal(Coarse)	WSG0827-28	Soil	7/23/2009				X
WSG0827	SLRC 050006 July 2009 Removal (TS)	WSG0827-29	Soil	7/23/2009				X
WSG0827	SLRC 050006 July 2009 Removal (Calc)	WSG0827-30	Soil	7/23/2009				X
WSG0827	SLRC 050006 July 2009 Removal (Fine)	WSG0827-31	Soil	7/23/2009				X

SDG Number	Sample ID	Lab ID	Matrix	Sample Collection Date	Parent Sample	Analysis		
						VOC	SVOC	MET
WSG0827	SLRC 050006 July 2009 Removal(Coarse)	WSG0827-32	Soil	7/23/2009				X

Note:

1. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample locations SLRC 040008 July 2009 Removal (Fine) and SLRC 040008 July 2009 Removal (Coarse).
2. Matrix spike/matrix spike duplicate (MS/MSD) was performed on sample locations SLRC 050006 July 2009 Removal (Fine) and SLRC 050006 July 2009 Removal (Coarse).

ANALYTICAL DATA PACKAGE DOCUMENTATION

The table below is the evaluation of the data package completeness.

Items Reviewed	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
1. Sample receipt condition		X		X	
2. Requested analyses and sample results		X		X	
3. Master tracking list		X		X	
4. Methods of analysis		X		X	
5. Reporting limits		X		X	
6. Sample collection date		X		X	
7. Laboratory sample received date		X		X	
8. Sample preservation verification (as applicable)		X		X	
9. Sample preparation/extraction/analysis dates		X		X	
10. Fully executed Chain-of-Custody (COC) form		X		X	
11. Narrative summary of QA or sample problems provided		X		X	
12. Data Package Completeness and Compliance		X		X	

QA - Quality Assurance

INORGANIC ANALYSIS INTRODUCTION

Analyses were performed according to United States Environmental Protection Agency (USEPA) SW-846 Method 6010B. Data were reviewed in accordance with USEPA National Functional Guidelines of July 2002.

The data review process is an evaluation of data on a technical basis rather than a determination of contract compliance. As such, the standards against which the data are being weighed may differ from those specified in the analytical method. It is assumed that the data package represents the best efforts of the laboratory and that it was already subjected to adequate and sufficient quality review prior to submission.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results are qualified with the following codes in accordance with the USEPA National Functional Guidelines:

- Concentration (C) Qualifiers
 - U The analyte was analyzed for but not detected. The associated value is the analyte instrument detection limit.
 - B The reported value was obtained from a reading less than the contract-required detection limit (CRDL), but greater than or equal to the instrument detection limit (IDL).
- Quantitation (Q) Qualifiers
 - E The reported value is estimated due to the presence of interference.
 - N Spiked sample recovery is not within control limits.
 - * Duplicate analysis is not within control limits.
- Validation Qualifiers
 - J The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
 - UJ The analyte was not detected above the reported sample detection limit. However, the reported limit is approximate and may or may not represent the actual limit of detection.
 - UB Analyte considered non-detect at the listed value due to associated blank contamination.
 - R The sample results are rejected.

Two facts should be noted by all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant quality control (QC) problems, the analysis is invalid and provides no information as to whether the compound is present or not. "R" values should not appear on data tables because they cannot be relied upon, even as a last resort. The second fact to keep in mind is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data but any value potentially contains error.

METALS ANALYSES

1. Holding Times

The specified holding times for the following methods are presented in the following table.

Method	Matrix	Holding Time	Preservation
SW-846 6010B	Water	180 days from collection to analysis	Cooled @ 4 °C; preserved to a pH of less than 2.
	Soil	180 days from collection to analysis	Cooled @ 4 °C.

All samples were analyzed within the specified holding times.

2. Blank Contamination

Quality assurance (QA) blanks (i.e., method and rinse blanks) are prepared to identify any contamination which may have been introduced into the samples during sample preparation or field activity. Method blanks measure laboratory contamination. Rinse blanks measure contamination of samples during field operations.

A blank action level (BAL) of five times the concentration of a detected compound in an associated blank (common laboratory contaminant compounds are calculated at ten times) is calculated for QA blanks containing concentrations greater than the method detection limit (MDL). The BAL is compared to the associated sample results to determine the appropriate qualification of the sample results, if needed.

Analytes were detected in the associated QA blanks; however, the associated sample results were greater than the BAL. No other qualification of the sample results was required.

3. Calibration

Satisfactory instrument calibration is established to provide that the instrument is capable of producing acceptable quantitative data. An initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of an experimental sequence. The continuing calibration verifies that the instrument's continuing performance is satisfactory.

3.1 Initial Calibration and Continuing Calibration

The correct number and type of standards were analyzed. The correlation coefficient of the initial calibration was greater than 0.995 for all non-ICP analytes and all initial calibration verification standard recoveries were within control limits.

All continuing calibration verification standard recoveries were within the control limit.

3.2 CRDL Check Standard

The CRDL check standard serves to verify the linearity of calibration of the analysis at the CRDL. The CRDL standard is not required for the analysis of aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), and potassium (K). The criteria used to evaluate the CRDL standard analysis are presented below in the CRDL standards evaluation table.

All CRDL standard recoveries were within control limits.

3.3 ICP Interference Control Sample (ICS)

The ICS verifies the laboratories interelement and background correction factors.

All ICS exhibited recoveries within the control limits.

4. Matrix Spike/Matrix Spike (MS/MSD) Analysis

MS/MSD data are used to assess the precision and accuracy of the analytical method.

4.1 MS/MSD Analysis

All metal analytes must exhibit a percent recovery within the established acceptance limits of 75% to 125%. The MS/MSD recovery control limits do not apply for MS/MSD performed on sample locations where the analyte's concentration detected in the parent sample exceeds the MS/MSD concentration by a factor of four or greater. In instance where this is true, the data will not be qualified even if the percent recovery does not meet the control limits and the laboratory qualifier "N" will be removed.

The MS/MSD analysis performed on sample location SLRC 040008 July 2009 Removal (Coarse) exhibited recoveries within the control limits.

All analytes associated with MS/MSD recoveries were within control limits with the exception of the following analyte present in the table below.

Sample Location	Analyte	MS Recovery	MSD Recovery
SLRC 040008 July 2009 Removal (Fine)	Lead	55%	197%
SLRC 050006 July 2009 Removal (Fine)	Lead	131%	149%
SLRC 050006 July 2009 Removal (Coarse)	Lead	AC	130%

The criteria used to evaluate MS/MSD recoveries are presented in the following table. In the case of an MS/MSD deviation, the sample results are qualified. The qualifications are applied to all sample results associated with this SDG.

Control limit	Sample Result	Qualification
MS/MSD percent recovery 30% to 74%	Non-detect	UJ
	Detect	J
MS/MSD percent recovery <30%	Non-detect	R
	Detect	J
MS/MSD percent recovery >125%	Non-detect	No Action
	Detect	J

4.2 Laboratory Duplicate Analysis

The laboratory duplicate relative percent difference (RPD) criterion is applied when parent and duplicate sample concentrations are greater than or equal to 5 times the CRDL. A control limit of 20% for water matrices and 35% for soil matrices is applied when the criteria above is true. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the CRDL, a control limit of one times the CRDL is applied for water matrices and two times the CRDL for soil matrices.

The MS/MSD was performed in replace of the laboratory duplicate analysis. Sample locations associated with MS/MSD recoveries exhibiting an RPD greater than of the control limit presented in the following table.

Sample Locations	Analyte
SLRC 040008 July 2009 Removal (Fine)	Lead

The criteria used to evaluate the RPD between the MS/MSD recoveries are presented in the following table. In the case of an RPD deviation, the sample results are qualified as documented in the table below.

Control Limit	Sample Result	Qualification
> UL	Non-detect	UJ
	Detect	J

5. Field Duplicate Analysis

Field duplicate analysis is used to assess the precision and accuracy of the field sampling procedures and analytical method. A control limit of 100% for soil matrices is applied to the RPD between the parent sample and the field duplicate. In the instance when the parent and/or duplicate sample concentrations are less than or equal to 5 times the RL, a control limit of three times the RL is applied for soil matrices.

Results for duplicate samples are summarized in the following table.

Sample ID/Duplicate ID	Analyte	Sample Result	Duplicate Result	RPD
SLRC 040007 July 2009 Removal (Calc)/ SLDUP 040002 July 2009 Removal (Calc)	Lead	56	53	5.5%
SLRC 040007 July 2009 Removal (Fine)/ SLDUP 040002 July 2009 Removal (Fine)	Lead	78	110	34.0%
SLRC 040007 July 2009 Removal (Coarse)/ SLDUP 040002 July 2009 Removal (Coarse)	Lead	42	22	62.5%

AC = Acceptable

The calculated RPDs between the parent sample and field duplicate were acceptable.

6. Laboratory Control Sample (LCS) Analysis

The LCS analysis is used to assess the precision and accuracy of the analytical method independent of matrix interferences. The analytes associated with the LCS analysis must exhibit a percent recovery between the control limits of 80% and 120%.

The LCS analysis exhibited recoveries within the control limits.

7. Serial Dilution

The serial dilution analysis is used to assess if a significant physical or chemical interference exists due to sample matrix. Analytes exhibiting concentrations greater than 50 times the MDL in the undiluted sample are evaluated to determine if matrix interference exists. These analytes are required to have less than a 10% difference (%D) between sample results from the undiluted (parent) sample and results associated with the same sample analyzed with a five-fold dilution.

The serial dilution performed on sample location SLRC 040004 July 2009 Removal (Fine) exhibited %D within the control limit.

8. System Performance and Overall Assessment

Overall system performance was acceptable. Other than for those deviations specifically mentioned in this review, the overall data quality is within the guidelines specified in the method.

DATA VALIDATION CHECKLIST FOR METAL

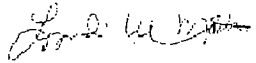
METALS; SW-846 6000	Reported		Performance Acceptable		Not Required
	No	Yes	No	Yes	
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)					
Tier II Validation					
Holding Times		X		X	
Reporting limits (units)		X		X	
Blanks					
A. Instrument Blanks					X
B. Method Blanks		X		X	
C. Equipment Blanks		X	X		
Laboratory Control Sample (LCS)		X		X	
Matrix Spike (MS) %R		X	X		
Matrix Spike Duplicate (MSD) %R		X	X		
MS/MSD Precision (RPD)		X	X		
Field Duplicate (RPD)		X		X	
ICP Serial Dilution		X		X	
Reporting Limit Verification		X		X	
Raw Data					X
Tier III Validation					
Initial Calibration Verification		X		X	
Continuing Calibration Verification		X		X	
CRDL Standard		X		X	
ICP Interference Check		X		X	
Transcription/calculation errors present				X	
Reporting limits adjusted to reflect sample dilutions		X		X	

%R Percent recovery

RPD Relative percent difference

VALIDATION PERFORMED BY: Lyndi Mott

SIGNATURE:



DATE: September 10, 2009

REVISION DATE: November 27, 2009

PEER REVIEW: Dennis Capria

DATE: September 16, 2009

**CHAIN OF CUSTODY/
CORRECTED SAMPLE ANALYSIS DATA SHEETS**

WSG 0824

Possible Hazard Identification		Sample Disposal		(A fee may be assessed if samples are retained longer than 1 month)	
<input checked="" type="checkbox"/> Non-Hazard	<input type="checkbox"/> Flammable	<input type="checkbox"/> Skin Irritant	<input type="checkbox"/> Poison B	<input type="checkbox"/> Unknown	<input type="checkbox"/> Return To Client
				<input checked="" type="checkbox"/> Disposal By Lab	
				<input type="checkbox"/> Archive For _____ Months	
Turn Around Time Required				OC Requirements (Specify)	
<input type="checkbox"/> 24 Hours	<input type="checkbox"/> 48 Hours	<input type="checkbox"/> 7 Days	<input type="checkbox"/> 14 Days	<input type="checkbox"/> 21 Days	<input checked="" type="checkbox"/> Other <u>5 Day</u>
1. Relinquished By <u>Tyler</u>		Date <u>7/23/09</u>	Time <u>1530</u>	Level <u>III</u>	
2. Relinquished By		Date	Time	1. Received By <u>M. Watts</u>	
3. Relinquished By		Date	Time	2. Received By	
		Date	Time	3. Received By	

R 7/24/09

Chain of Custody Record

WSG 0827

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TAL-4142 (0408)

Client Arcadis			Project Manager Mark Kittinger			Date 7-23-09		Chain of Custody Number 017609	
Address 28550 Cabot Dr Suite 500			Telephone Number (Area Code)/Fax Number 248-994-2288			Lab Number HC WT		Page 1 of 1	
City Novi	State MI	Zip Code 48377	Site Contact T. Sclafani		Lab Contact W. Taper		Analysis (Attach list if more space is needed)		
Project Name and Location (State) US Coast Guard Oil Station Lubington			Carrier/Waybill Number 8689 3938 7850			Special Instructions/ Conditions of Receipt			
Contract/Purchase Order/Quote No. 009-0066									

Sample I.D. No. and Description (Containers for each sample may be combined on one line)			Date	Time	Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		Lead																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Possible Hazard Identification <input checked="" type="checkbox"/> Non-Hazard <input type="checkbox"/> Flammable <input type="checkbox"/> Skin Irritant <input type="checkbox"/> Poison B <input type="checkbox"/> Unknown				Sample Disposal <input type="checkbox"/> Return To Client <input checked="" type="checkbox"/> Disposal By Lab <input type="checkbox"/> Archive For _____ Months				(A fee may be assessed if samples are retained longer than 1 month)			
Turn Around Time Required <input type="checkbox"/> 24 Hours <input type="checkbox"/> 48 Hours <input type="checkbox"/> 7 Days <input type="checkbox"/> 14 Days <input type="checkbox"/> 21 Days <input checked="" type="checkbox"/> Other 5 Day				QC Requirements (Specify) Level III				Custody Seal no 10 fed			
1. Relinquished By T. K. [Signature]		Date 7/23/09		Time 1520		1. Received By M. [Signature]		Date 7/24/09		Time 1117	
2. Relinquished By		Date		Time		2. Received By		Date		Time	
3. Relinquished By		Date		Time		3. Received By		Date		Time	
Comments											

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

R 7/24/09

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0826
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:41

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-01 (SLEB 020002 July 2009 Removal - Water - NonPotable)						Sampled: 07/22/09 17:15			
Metals									
Lead	0.14	J	ug/L	0.12	0.40	I	07/28/09 12:51	gaf	9070628 SW 6020A

ARCADIS - MICHIGAN
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Received: 07/24/09
Reported: 07/30/09 15:41

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-02 (SLRC 040001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 15:55			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-03 (SLRC 040001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	150		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-04 (SLRC 040001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	260		mg/kg	1.2	1	07/29/09 13:32	gaf	9070688	SW 6010B
Sample ID: WSG0826-05 (SLRC 040001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	75		mg/kg	1.2	1	07/29/09 13:36	gaf	9070688	SW 6010B
Sample ID: WSG0826-06 (SLRC 040002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:05			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-07 (SLRC 040002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	66		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-08 (SLRC 040002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	100		mg/kg	1.2	1	07/29/09 13:40	gaf	9070688	SW 6010B
Sample ID: WSG0826-09 (SLRC 040002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	43		mg/kg	1.2	1	07/29/09 13:44	gaf	9070688	SW 6010B
Sample ID: WSG0826-10 (SLRC 040004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:20			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-11 (SLRC 040004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	260		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-12 (SLRC 040004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	330		mg/kg	1.2	1	07/29/09 13:47	gaf	9070688	SW 6010B
Sample ID: WSG0826-13 (SLRC 040004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	210		mg/kg	1.2	1	07/29/09 13:51	gaf	9070688	SW 6010B
Sample ID: WSG0826-14 (SLRC 040005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:30			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035

ARCADIS - MICHIGAN
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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-15 (SLRC 040005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	81		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-16 (SLRC 040005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	160		mg/kg	1.2	1	07/29/09 14:06	gaf	9070688	SW 6010B
Sample ID: WSG0826-17 (SLRC 040005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	46		mg/kg	1.2	1	07/29/09 14:09	gaf	9070688	SW 6010B
Sample ID: WSG0826-18 (SLRC 040006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:35			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-19 (SLRC 040006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	210		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-20 (SLRC 040006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	370		mg/kg	1.2	1	07/29/09 14:13	gaf	9070688	SW 6010B
Sample ID: WSG0826-21 (SLRC 040006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	120		mg/kg	1.2	1	07/29/09 14:16	gaf	9070688	SW 6010B
Sample ID: WSG0826-22 (SLRC 040007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:37			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-23 (SLRC 040007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	56		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-24 (SLRC 040007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	78		mg/kg	1.2	1	07/29/09 14:20	gaf	9070688	SW 6010B
Sample ID: WSG0826-25 (SLRC 040007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	42		mg/kg	1.2	1	07/29/09 14:24	gaf	9070688	SW 6010B
Sample ID: WSG0826-26 (SLDUP 040002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-27 (SLDUP 040002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	53		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B

ARCADIS - MICHIGAN
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Received: 07/24/09
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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-28 (SLDUP 040002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	110		mg/kg	1.2	1	07/29/09 14:27	gaf	9070688	SW 6010B
Sample ID: WSG0826-29 (SLDUP 040002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	22		mg/kg	1.2	1	07/29/09 14:31	gaf	9070688	SW 6010B
Sample ID: WSG0826-30 (SLRC 040008 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:45			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-31 (SLRC 040008 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	93		mg/kg	0.048	0.04	07/30/09 15:38	mmun	9070730	SW 6010B
Sample ID: WSG0826-32 (SLRC 040008 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	120	J	mg/kg	1.2	1	07/29/09 14:34	gaf	9070688	SW 6010B
Sample ID: WSG0826-33 (SLRC 040008 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	33		mg/kg	1.2	1	07/29/09 14:56	gaf	9070688	SW 6010B

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
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Mr. Troy Sclafani

Work Order: WSG0827
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:52

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-01 (SLRC 040010 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 09:39			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-02 (SLRC 040010 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	47		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-03 (SLRC 040010 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	65		mg/kg	1.2	1	07/29/09 15:28	gaf	9070689	SW 6010B
Sample ID: WSG0827-04 (SLRC 040010 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	38		mg/kg	1.2	1	07/29/09 15:43	gaf	9070689	SW 6010B
Sample ID: WSG0827-05 (SLRC 040011 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 09:48			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-06 (SLRC 040011 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	61		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-07 (SLRC 040011 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	85		mg/kg	1.2	1	07/29/09 15:47	gaf	9070689	SW 6010B
Sample ID: WSG0827-08 (SLRC 040011 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	24		mg/kg	1.2	1	07/29/09 15:50	gaf	9070689	SW 6010B
Sample ID: WSG0827-09 (SLRC 050001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 10:55			
General Chemistry Parameters									
% Solids	94		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-10 (SLRC 050001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	200		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-11 (SLRC 050001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 15:54	gaf	9070689	SW 6010B
Sample ID: WSG0827-12 (SLRC 050001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	220		mg/kg	1.2	1	07/29/09 15:58	gaf	9070689	SW 6010B
Sample ID: WSG0827-13 (SLRC 050002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:00			
General Chemistry Parameters									
% Solids	93		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0827
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:52

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-14 (SLRC 050002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	180		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-15 (SLRC 050002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	170		mg/kg	1.2	1	07/29/09 16:02	gaf	9070689	SW 6010B
Sample ID: WSG0827-16 (SLRC 050002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 16:05	gaf	9070689	SW 6010B
Sample ID: WSG0827-17 (SLRC 050003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:10			
General Chemistry Parameters									
% Solids	96		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-18 (SLRC 050003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	29		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-19 (SLRC 050003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	23		mg/kg	1.2	1	07/29/09 16:09	gaf	9070689	SW 6010B
Sample ID: WSG0827-20 (SLRC 050003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	31		mg/kg	1.2	1	07/29/09 16:12	gaf	9070689	SW 6010B
Sample ID: WSG0827-21 (SLRC 050004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:20			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-22 (SLRC 050004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	82		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-23 (SLRC 050004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	100		mg/kg	1.2	1	07/29/09 16:16	gaf	9070689	SW 6010B
Sample ID: WSG0827-24 (SLRC 050004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	72		mg/kg	1.2	1	07/29/09 16:31	gaf	9070689	SW 6010B
Sample ID: WSG0827-25 (SLRC 050005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:30			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-26 (SLRC 050005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	120		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0827
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:52

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-27 (SLRC 050005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	97		mg/kg	1.2	1	07/29/09 16:34	gaf	9070689	SW 6010B
Sample ID: WSG0827-28 (SLRC 050005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 16:38	gaf	9070689	SW 6010B
Sample ID: WSG0827-29 (SLRC 050006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:35			
General Chemistry Parameters									
% Solids	93		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-30 (SLRC 050006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	230		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-31 (SLRC 050006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	180	J	mg/kg	1.2	1	07/29/09 16:41	gaf	9070689	SW 6010B
Sample ID: WSG0827-32 (SLRC 050006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	250	J	mg/kg	1.2	1	07/29/09 16:52	gaf	9070689	SW 6010B

November 21, 2008

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WRK0541
Project Name: USCG Ludington
Project Number: DE000122.0001.00003

Attn: Mr. Troy Sclafani

Date Received: 11/18/08

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLMW-01-NOV2008-SE	WRK0541-01	11/12/08 14:20
SLMW-02-NOV2008-SE	WRK0541-02	11/12/08 15:05
SLMW-03-NOV2008-SE	WRK0541-03	11/12/08 15:50
SLDUP-01-NOV2008-SE	WRK0541-04	11/12/08

Samples were received on ice into laboratory at a temperature of 0 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WRK0541
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 11/18/08
Reported: 11/21/08 14:26

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WRK0541-01 (SLMW-01-NOV2008-SE - Ground Water)						Sampled: 11/12/08 14:20				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-02 (SLMW-02-NOV2008-SE - Ground Water)						Sampled: 11/12/08 15:05				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-03 (SLMW-03-NOV2008-SE - Ground Water)						Sampled: 11/12/08 15:50				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Sample ID: WRK0541-04 (SLDUP-01-NOV2008-SE - Ground Water)						Sampled: 11/12/08				
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	11/21/08 13:27	gaf	8110431	SW 6020A

Received: 11/18/08
Reported: 11/21/08 14:26

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup	%	Dup	% REC	RPD		Q
								Result	REC	%REC	Limits	RPD	Limit	
Metals														
Lead	8110431			ug/L	0.12	0.40	<0.12							
Metals Dissolved														
Lead	8110431			ug/L	0.12	0.40	<0.12							

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WRK0541
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 11/18/08
Reported: 11/21/08 14:26

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	8110431		50.000	ug/L	0.12	0.40	55.3		111		80-120			
Metals Dissolved														
Lead	8110431		50.000	ug/L	0.12	0.40	55.3		111		80-120			

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WRK0541
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 11/18/08
Reported: 11/21/08 14:26

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
QC Source Sample: WRK0541-01														
Lead	8110431	<0.12	50.000	ug/L	0.12	0.40	52.2	52.1	104	104	75-125	0	20	
Metals Dissolved														
QC Source Sample: WRK0541-01														
Lead	8110431	<0.12	50.000	ug/L	0.12	0.40	52.2	52.1	104	104	75-125	0	20	

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WRK0541
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 11/18/08
Reported: 11/21/08 14:26

CERTIFICATION SUMMARY

TestAmerica Watertown

Method	Matrix	Nelac	Michigan
SW 6020A	Water - NonPotable		

TAL-4124 (1007)

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☒

THE LEADER IN ENVIRONMENTAL TESTING

WRK 0541

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ *Return To Client*

☒ Disposal By Lab ☐ Archive For _____ Months

(A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days☒ Other Standard

QC Requirements (Specify)

1. Relinquished By

A. Peckens *Chas. Parker*

Date 11/13/08 Time 2020

1. Received By

Arcadis Fridge

Date 11/13/08 Time 2020

2. Relinquished By

Matt Williams ~~Marshall Williams~~

Date	Time
11/14/08	11:30

2. Received By

[Signature]

Date	11/14/08	Time	1130
------	----------	------	------

3. Relinquished By

[Signature]

Date	Time
11/11/09	15:30

3. Received By

Herby Burns

Date	Time
11/18/08	

Comments

11/17/08 10:00am

11/18/08 1137

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Q 11/18/08

February 20, 2009

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WSB0399
Project Name: USCG Ludington
Project Number: DE000122.0001.00003

Attn: Mr. Troy Sclafani

Date Received: 02/13/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLMW-03 Feb 2009-SE	WSB0399-01	02/09/09 17:05
SLMW-02 Feb 2009-SE	WSB0399-02	02/09/09 16:25
SLMW-01 Feb 2009-SE	WSB0399-03	02/09/09 15:30
MW-DUP-01 Feb 2009-SE	WSB0399-04	02/09/09
MW-EB-01 Feb 2009-SE	WSB0399-05	02/09/09 17:20


Samples were received on ice into laboratory at a temperature of 0 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSB0399-01 (SLMW-03 Feb 2009-SE - Ground Water)							Sampled: 02/09/09 17:05			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-02 (SLMW-02 Feb 2009-SE - Ground Water)							Sampled: 02/09/09 16:25			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-03 (SLMW-01 Feb 2009-SE - Ground Water)							Sampled: 02/09/09 15:30			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	0.13	J	ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-04 (MW-DUP-01 Feb 2009-SE - Ground Water)							Sampled: 02/09/09			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Sample ID: WSB0399-05 (MW-EB-01 Feb 2009-SE - Ground Water)							Sampled: 02/09/09 17:20			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	02/20/09 11:28	gaf	9020345	SW 6020A

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sciafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9020345			ug/L	0.12	0.40	<0.12							
Metals Dissolved														
Lead	9020345			ug/L	0.12	0.40	<0.12							

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sciafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

CCV QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9020345		20.000	ug/L	N/A	N/A	19.8		99		90-110			
Metals Dissolved														
Lead	9020345		20.000	ug/L	N/A	N/A	19.8		99		0-200			

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9020345		50.000	ug/L	0.12	0.40	49.4		99		85-115			
Metals Dissolved														
Lead	9020345		50.000	ug/L	0.12	0.40	49.4		99		85-115			

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
QC Source Sample: WSB0399-03														
Lead	9020345	<0.12	50.000	ug/L	0.12	0.40	47.8	48.5	96	97	75-125	1	20	
Metals Dissolved														
QC Source Sample: WSB0399-03														
Lead	9020345	0.130	50.000	ug/L	0.12	0.40	47.8	48.5	95	97	75-125	1	20	

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSB0399
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 02/13/09
Reported: 02/20/09 11:51

DATA QUALIFIERS AND DEFINITIONS

J Results reported between the Method Detection Limit (MDL) and Limit of Quantitation (LOQ) are less certain than results at or above the LOQ.

ADDITIONAL COMMENTS

ID#: **12357**

**CHAIN OF CUSTODY & LABORATORY
ANALYSIS REQUEST FORM**

Page 1 of 1

Lab Work Order # **WSB0399**

Send Results to:	Contact & Company Name: Troy Scalfani / ARCADIS		Telephone: 248-994-2288		Preservative	HNO₃	HNO₃									Keys Preservation Key: A. H ₂ SO ₄ B. HCL C. HNO ₃ D. NaOH E. None F. Other G. Other H. Other Matrix Key: SO - Soil W - Water T - Tissue SE - Sediment SL - Sludge A - Air NL - NAPL/Oil SW - Sample Wipe Other													
	Address: 28550 Cabot Dr		Fax: 248-994-2241		Filtered (✓)		<input checked="" type="checkbox"/>																						
	City: Novi State: MI Zip: 48377		E-mail Address: Troy.Scalfani@arcadis-us.com		# of Containers	7	7																						
	Container Information				250ml	250ml																							
PARAMETER ANALYSIS & METHOD																													
Project Name/Location/State: USCG Station Ludington, MI					Project #: DE000122.0001.00003					<div style="display: flex; flex-direction: column; align-items: center;"> <div>SM 6020A</div> <div>total lead</div> <div>SM 6020A</div> <div>disolved lead</div> </div>																			
Sampler's Printed Name: Amy O'Neil					Sampler's Signature: <i>Amy C O'Neil</i>																								
Sample ID					Collection		Type (✓)		Matrix																				
					Date	Time	Comp	Grab																					
-01	SLHW-03Feb2009-SE				04/09/09	1705		✓	GW	1	1																		
-02	SLHW-02Feb2009-SE				02/09/09	11025		✓	GW	1	1																		
-03	SLHW-01Feb2009-SE				02/09/09	1530		✓	GW	3	3	MS/MSD																	
-04	MWDUPO1Feb2009-SE				04/09/09	-		✓	GW	1	1																		
-05	MWEB01Feb2009-SE				02/09/09	1720		✓	GW	1	1																		
Special Instructions/Comments: Standard TAT <input type="checkbox"/> Special QA/QC Instructions (✓):																													
Laboratory Information and Receipt					Relinquished By					Received By					Relinquished By					Laboratory Received By									
Lab Name:					Cooler Custody Seal (✓)					Printed Name: Amy O'Neil					Printed Name: Sim Morrison					Printed Name: Sim Morrison					Printed Name: Michelle Patton				
<input type="checkbox"/> Cooler packed with ice (✓)					<input type="checkbox"/> Intact <input type="checkbox"/> Not Intact					Signature: <i>Amy C O'Neil</i>					Signature: <i>Sim Morrison</i>					Signature: <i>Sim Morrison</i>					Signature: <i>Michelle Patton</i>				
Specify Turnaround Requirements:					Sample Receipt:					Firm: TestAmerica					Firm/Courier: TestAmerica					Firm: TA					Firm: TA				
Shipping Tracking #:					Condition/Cooler Temp:					Date/Time: 2-12-09 1405					Date/Time: 2/12/09 1405					Date/Time: 2/12/09 1730					Date/Time: 2/13/09 1203				

2/21/09

O'Dea

May 27, 2009

Client: ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116

Work Order: WSE0595
Project Name: USCG Ludington
Project Number: DE000122.0001.00003

Attn: Mr. Jonathan Burton

Date Received: 05/20/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLMW01 May 1009 SE	WSE0595-01	05/18/09 12:55
SLMW02 May 1009 SE	WSE0595-02	05/18/09 13:40
SLMW03 May 1009 SE	WSE0595-03	05/18/09 14:20
MW Dup01 May 1009 SE	WSE0595-04	05/18/09
MW EB01 May 1009 SE	WSE0595-05	05/18/09 14:45

Samples were received on ice into laboratory at a temperature of 5 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSE0595-01 (SLMW01 May 1009 SE - Ground Water)							Sampled: 05/18/09 12:55			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-02 (SLMW02 May 1009 SE - Ground Water)							Sampled: 05/18/09 13:40			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-03 (SLMW03 May 1009 SE - Ground Water)							Sampled: 05/18/09 14:20			
Metals										
Lead	0.14	J	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-04 (MW Dup01 May 1009 SE - Ground Water)							Sampled: 05/18/09			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	<0.12		ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Sample ID: WSE0595-05 (MW EB01 May 1009 SE - Ground Water)							Sampled: 05/18/09 14:45			
Metals										
Lead	0.18	J	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A
Metals Dissolved										
Lead	0.19	J	ug/L	0.12	0.40	1	05/26/09 08:52	gaf	9050559	SW 6020A

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9050559			ug/L	0.12	0.40	<0.12							
Metals Dissolved														
Lead	9050559			ug/L	0.12	0.40	<0.12							

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

CCV QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9050559		20	ug/L	N/A	N/A	20.7		104		90-110			
Metals Dissolved														
Lead	9050559		20	ug/L	N/A	N/A	20.7		104		0-200			

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9050559		50	ug/L	0.12	0.40	51.7		103		85-115			
Metals Dissolved														
Lead	9050559		50	ug/L	0.12	0.40	51.7		103		85-115			

ARCADIS - MICHIGAN
10559 Citation Drive, Suite 100
Brighton, MI 48116
Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
QC Source Sample: WSE0595-01														
Lead	9050559	<0.12	50	ug/L	0.12	0.40	49.6	49.3	99	99	75-125	1	20	
Metals Dissolved														
QC Source Sample: WSE0595-01														
Lead	9050559	<0.12	50	ug/L	0.12	0.40	49.6	49.3	99	99	75-125	1	20	

ARCADIS - MICHIGAN
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Mr. Jonathan Burton

Work Order: WSE0595
Project: USCG Ludington
Project Number: DE000122.0001.00003

Received: 05/20/09
Reported: 05/27/09 08:27

DATA QUALIFIERS AND DEFINITIONS

J Results reported between the Method Detection Limit (MDL) and Limit of Quantitation (LOQ) are less certain than results at or above the LOQ.

ADDITIONAL COMMENTS

July 30, 2009

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WSG0776
Project Name: USCG Ludington
Project Number: D09-0066

Attn: Mr. Troy Sclafani

Date Received: 07/23/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 020004 July 2009 Removal (TS)	WSG0776-01	07/22/09 10:26
SLRC 020004 July 2009 Removal (Calc)	WSG0776-02	07/22/09
SLRC 020004 July 2009 Removal(Fine)	WSG0776-03	07/22/09 10:26
SLRC 020004 July 2009 Removal (Coarse)	WSG0776-04	07/22/09 10:26
SLRC 020005 July 2009 Removal (TS)	WSG0776-05	07/22/09 10:34
SLRC 020005 July 2009 Removal (Calc)	WSG0776-06	07/22/09 10:34
SLRC 020005 July 2009 Removal (Fine)	WSG0776-07	07/22/09 10:34
SLRC 020005 July 2009 Removal (Coarse)	WSG0776-08	07/22/09 10:34
SLRC 020006 July 2009 Removal (TS)	WSG0776-09	07/22/09 11:34
SLRC 020006 July 2009 Removal (Calc)	WSG0776-10	07/22/09 11:34
SLRC 020006 July 2009 Removal (Fine)	WSG0776-11	07/22/09 11:34
SLRC 020006 July 2009 Removal (Coarse)	WSG0776-12	07/22/09 11:34
SLDUP 020001 July 2009 Removal (TS)	WSG0776-13	07/22/09
SLDUP 020001 July 2009 Removal(Calc)	WSG0776-14	07/22/09
SLDUP 020001 July 2009 Removal(Fine)	WSG0776-15	07/22/09
SLDUP 020001 July 2009 Removal (Coarse)	WSG0776-16	07/22/09

Samples were received on ice into laboratory at a temperature of 4 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sciafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0776-01 (SLRC 020004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:26			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:14	LER	9070588	SW 5035
Sample ID: WSG0776-02 (SLRC 020004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	31		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-03 (SLRC 020004 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/22/09 10:26			
Metals									
Lead	47		mg/kg	1.2	1	07/29/09 08:37	gaf	9070671	SW 6010B
Sample ID: WSG0776-04 (SLRC 020004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:26			
Metals									
Lead	20		mg/kg	1.2	1	07/29/09 08:40	gaf	9070671	SW 6010B
Sample ID: WSG0776-05 (SLRC 020005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:34			
General Chemistry Parameters									
% Solids	97		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0776-06 (SLRC 020005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	83		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-07 (SLRC 020005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 08:44	gaf	9070671	SW 6010B
Sample ID: WSG0776-08 (SLRC 020005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:34			
Metals									
Lead	53		mg/kg	1.2	1	07/29/09 08:47	gaf	9070671	SW 6010B
Sample ID: WSG0776-09 (SLRC 020006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 11:34			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0776-10 (SLRC 020006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	91		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-11 (SLRC 020006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 08:51	gaf	9070671	SW 6010B
Sample ID: WSG0776-12 (SLRC 020006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 11:34			
Metals									
Lead	67		mg/kg	1.2	1	07/29/09 08:55	gaf	9070671	SW 6010B
Sample ID: WSG0776-13 (SLDUP 020001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0776-14 (SLDUP 020001 July 2009 Removal(Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	57		mg/kg	0.048	0.04	07/30/09 10:15	mmm	9070730	SW 6010B
Sample ID: WSG0776-15 (SLDUP 020001 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	78		mg/kg	1.2	1	07/29/09 08:58	gaf	9070671	SW 6010B
Sample ID: WSG0776-16 (SLDUP 020001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	44		mg/kg	1.2	1	07/29/09 09:02	gaf	9070671	SW 6010B

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9070671			mg/kg	N/A	1.2	<1.2							

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

LABORATORY DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
General Chemistry Parameters													
QC Source Sample: WSG0689-09													
% Solids	9070588	86.9		%	N/A	N/A	86.1				1	20	
QC Source Sample: WSG0689-13													
% Solids	9070588	85.3		%	N/A	N/A	85.7				0	20	
QC Source Sample: WSG0790-01													
% Solids	9070589	84.4		%	N/A	N/A	84.1				0	20	
QC Source Sample: WSG0790-02													
% Solids	9070589	96.9		%	N/A	N/A	96.8				0	20	

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lcad	9070671		100	mg/kg	N/A	1.2	111		111		80-120			

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
QC Source Sample: WSG0780-19														
Lead	9070671	79.4	100	mg/kg	N/A	1.2	196	210	117	131	80-120	7	18	M7
QC Source Sample: WSG0780-20														
Lead	9070671	42.4	100	mg/kg	N/A	1.2	146	149	104	107	80-120	2	18	

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sciafani

Work Order: WSG0776
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:32

DATA QUALIFIERS AND DEFINITIONS

M7 The MS and/or MSD were above the acceptance limits. See Blank Spike (LCS).

ADDITIONAL COMMENTS

WS 60776

Q 7123/09

July 30, 2009

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WSG0780
Project Name: USCG Ludington
Project Number: D09-0066

Attn: Mr. Troy Sclafani

Date Received: 07/23/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 010004 July 2009 Removal (TS)	WSG0780-01	07/21/09 15:44
SLRC 010004 July 2009 Removal (Calc)	WSG0780-02	07/21/09 15:44
SLRC 010004 July 2009 Removal (Fine)	WSG0780-03	07/21/09 15:44
SLRC 010004 July 2009 Removal (Coarse)	WSG0780-04	07/21/09 15:44
SLRC 010005 July 2009 Removal (TS)	WSG0780-05	07/21/09 15:47
SLRC 010005 July 2009 Removal (Calc)	WSG0780-06	07/21/09 15:47
SLRC 010005 July 2009 Removal (Fine)	WSG0780-07	07/21/09 15:47
SLRC 010005 July 2009 Removal (Coarse)	WSG0780-08	07/21/09 15:47
SLRC 010006 July 2009 Removal (TS)	WSG0780-09	07/21/09 15:58
SLRC 010006 July 2009 Removal (Calc)	WSG0780-10	07/21/09 15:58
SLRC 010006 July 2009 Removal (Fine)	WSG0780-11	07/21/09 15:58
SLRC 010006 July 2009 Removal (Coarse)	WSG0780-12	07/21/09 15:58
SLRC 010007 July 2009 Removal (TS)	WSG0780-13	07/21/09 16:04
SLRC 010007 July 2009 Removal (Calc)	WSG0780-14	07/21/09 16:04
SLRC 010007 July 2009 Removal (Fine)	WSG0780-15	07/21/09 16:04
SLRC 010007 July 2009 Removal (Coarse)	WSG0780-16	07/21/09 16:04
SLRC 010012 July 2009 Removal (TS)	WSG0780-17	07/22/09 08:55
SLRC 010012 July 2009 Removal (Calc)	WSG0780-18	07/22/09 08:55
SLRC 010012 July 2009 Removal (Fine)	WSG0780-19	07/22/09 08:55
SLRC 010012 July 2009 Removal (Coarse)	WSG0780-20	07/22/09 08:55
SLEB 010001 July 2009 Removal	WSG0780-21	07/22/09 09:50
SLRC 020001 July 2009 Removal (TS)	WSG0780-22	07/22/09 10:07
SLRC 020001 July 2009 Removal (Calc)	WSG0780-23	07/22/09 10:07
SLRC 020001 July 2009 Removal (Fine)	WSG0780-24	07/22/09 10:07
SLRC 020001 July 2009 Removal (Coarse)	WSG0780-25	07/22/09 10:07
SLRC 020002 July 2009 Removal (TS)	WSG0780-26	07/22/09 10:14

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0780
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:29

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 020002 July 2009 Removal (Calc)	WSG0780-27	07/22/09 10:14
SLRC 020002 July 2009 Removal (Fine)	WSG0780-28	07/22/09 10:14
SLRC 020002 July 2009 Removal (Coarse)	WSG0780-29	07/22/09 10:14

Samples were received on ice into laboratory at a temperature of 8 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0780
Project: USCG Ludington
Project Number: D09-0066

Received: 07/23/09
Reported: 07/30/09 13:29

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-01 (SLRC 010004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:44			
General Chemistry Parameters									
% Solids	100		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-02 (SLRC 010004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	22		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-03 (SLRC 010004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	26		mg/kg	1.2	1	07/29/09 09:16	gaf	9070671	SW 6010B
Sample ID: WSG0780-04 (SLRC 010004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:44			
Metals									
Lead	14		mg/kg	1.2	1	07/29/09 09:20	gaf	9070671	SW 6010B
Sample ID: WSG0780-05 (SLRC 010005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:47			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-06 (SLRC 010005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	59		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-07 (SLRC 010005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	47		mg/kg	1.2	1	07/29/09 09:23	gaf	9070671	SW 6010B
Sample ID: WSG0780-08 (SLRC 010005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:47			
Metals									
Lead	66		mg/kg	1.2	1	07/29/09 09:27	gaf	9070671	SW 6010B
Sample ID: WSG0780-09 (SLRC 010006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 15:58			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-10 (SLRC 010006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	240		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-11 (SLRC 010006 July 2009 Removal(Fine) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	310		mg/kg	1.2	1	07/29/09 09:30	gaf	9070671	SW 6010B
Sample ID: WSG0780-12 (SLRC 010006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 15:58			
Metals									
Lead	170		mg/kg	1.2	1	07/29/09 09:34	gaf	9070671	SW 6010B
Sample ID: WSG0780-13 (SLRC 010007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/21/09 16:04			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-14 (SLRC 010007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	45		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-15 (SLRC 010007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	49		mg/kg	1.2	1	07/29/09 09:37	gaf	9070671	SW 6010B
Sample ID: WSG0780-16 (SLRC 010007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/21/09 16:04			
Metals									
Lead	43		mg/kg	1.2	1	07/29/09 09:41	gaf	9070671	SW 6010B
Sample ID: WSG0780-17 (SLRC 010012 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 08:55			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-18 (SLRC 010012 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	63		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-19 (SLRC 010012 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	79		mg/kg	1.2	1	07/29/09 09:44	gaf	9070671	SW 6010B
Sample ID: WSG0780-20 (SLRC 010012 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 08:55			
Metals									
Lead	42		mg/kg	1.2	1	07/29/09 10:06	gaf	9070671	SW 6010B

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Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-21 (SLEB 010001 July 2009 Removal - Water - NonPotable)							Sampled: 07/22/09 09:50			
Metals										
Lead	<0.12		ug/L	0.12	0.40	1	07/29/09 14:02	gaf	9070624	SW 6020A

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0780-22 (SLRC 020001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:07			
General Chemistry Parameters									
% Solids	96		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-23 (SLRC 020001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	35		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-24 (SLRC 020001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	54		mg/kg	1.2	1	07/29/09 10:17	gaf	9070671	SW 6010B
Sample ID: WSG0780-25 (SLRC 020001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:07			
Metals									
Lead	23		mg/kg	1.2	1	07/29/09 10:20	gaf	9070671	SW 6010B
Sample ID: WSG0780-26 (SLRC 020002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 10:14			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/23/09 16:15	LER	9070589	SW 5035
Sample ID: WSG0780-27 (SLRC 020002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	13		mg/kg	0.048	0.04	07/30/09 11:45	mmm	9070730	SW 6010B
Sample ID: WSG0780-28 (SLRC 020002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	17		mg/kg	1.2	1	07/29/09 10:45	gaf	9070672	SW 6010B
Sample ID: WSG0780-29 (SLRC 020002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 10:14			
Metals									
Lead	11		mg/kg	1.2	1	07/29/09 10:48	gaf	9070672	SW 6010B

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LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070624			ug/L	0.12	0.40	<0.12							
Lead	9070671			mg/kg	N/A	1.2	<1.2							
Lead	9070672			mg/kg	N/A	1.2	<1.2							

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LABORATORY DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
General Chemistry Parameters													
QC Source Sample: WSG0790-01													
% Solids	9070589	84.4		%	N/A	N/A	84.1				0	20	
QC Source Sample: WSG0790-02													
% Solids	9070589	96.9		%	N/A	N/A	96.8				0	20	

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LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9070624		50	ug/L	0.12	0.40	54.3		109		80-120			
Lead	9070671		100	mg/kg	N/A	1.2	111		111		80-120			
Lead	9070672		100	mg/kg	N/A	1.2	104		104		80-120			

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MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
QC Source Sample: WSG0761-10														
Lead	9070624	<0.12	50	ug/L	0.12	0.40	55.3	58.0	111	116	80-120	5	20	
QC Source Sample: WSG0780-19														
Lead	9070671	79.4	100	mg/kg	N/A	1.2	196	210	117	131	80-120	7	18	M7
QC Source Sample: WSG0780-20														
Lead	9070671	42.4	100	mg/kg	N/A	1.2	146	149	104	107	80-120	2	18	
QC Source Sample: WSG0822-24														
Lead	9070672	24.4	100	mg/kg	N/A	1.2	120	131	96	107	80-120	9	18	
QC Source Sample: WSG0822-25														
Lead	9070672	13.0	100	mg/kg	N/A	1.2	118	124	105	111	80-120	5	18	

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DATA QUALIFIERS AND DEFINITIONS

M7 The MS and/or MSD were above the acceptance limits. See Blank Spike (LCS).

ADDITIONAL COMMENTS

WS 60780

27/23/09

July 30, 2009

Client: ARCADIS - MICHIGAN
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Novi, MI 48377

Work Order: WSG0822
Project Name: USCG Ludington
Project Number: D09-0066

Attn: Mr. Troy Sclafani

Date Received: 07/24/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 050007 July 2009 Removal (TS)	WSG0822-01	07/23/09 11:45
SLRC 050007 July 2009 Removal (Calc)	WSG0822-02	07/23/09 11:45
SLRC 050007 July 2009 Removal (Fine)	WSG0822-03	07/23/09 11:45
SLRC 050007 July 2009 Removal (Coarse)	WSG0822-04	07/23/09 11:45
SLEB 030003 July 2009 Removal	WSG0822-05	07/23/09 12:30
SLRC 030006 July 2009 Removal (TS)	WSG0822-06	07/23/09 13:00
SLRC 030006 July 2009 Removal (Calc)	WSG0822-07	07/23/09 13:00
SLRC 030006 July 2009 Removal (Fine)	WSG0822-08	07/23/09 13:00
SLRC 030006 July 2009 Removal (Coarse)	WSG0822-09	07/23/09 13:00
SLRC 030001 July 2009 Removal (TS)	WSG0822-10	07/23/09 12:35
SLRC 030001 July 2009 Removal (Calc)	WSG0822-11	07/23/09 12:35
SLRC 030001 July 2009 Removal (Fine)	WSG0822-12	07/23/09 12:35
SLRC 030001 July 2009 Removal (Coarse)	WSG0822-13	07/23/09 12:35
SLRC 030004 July 2009 Removal (TS)	WSG0822-14	07/23/09 12:50
SLRC 030004 July 2009 Removal (Calc)	WSG0822-15	07/23/09 12:50
SLRC 030004 July 2009 Removal (Fine)	WSG0822-16	07/23/09 12:50
SLRC 030004 July 2009 Removal (Coarse)	WSG0822-17	07/23/09 12:50
SLDUP 030003 July 2009 Removal (TS)	WSG0822-18	07/23/09
SLDUP 030003 July 2009 Removal (Calc)	WSG0822-19	07/23/09
SLDUP 030003 July 2009 Removal (Fine)	WSG0822-20	07/23/09
SLDUP 030003 July 2009 Removal (Coarse)	WSG0822-21	07/23/09
SLRC 030005 July 2009 Removal (TS)	WSG0822-22	07/23/09 12:55
SLRC 030005 July 2009 Removal (Calc)	WSG0822-23	07/23/09 12:55
SLRC 030005 July 2009 Removal (Fine)	WSG0822-24	07/23/09 12:55
SLRC 030005 July 2009 Removal (Coarse)	WSG0822-25	07/23/09 12:55
SLRC 030002 July 2009 Removal (TS)	WSG0822-26	07/23/09 12:40

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SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 030002 July 2009 Removal (Calc)	WSG0822-27	07/23/09 12:40
SLRC 030002 July 2009 Removal (Fine)	WSG0822-28	07/23/09 12:40
SLRC 030002 July 2009 Removal (Coarse)	WSG0822-29	07/23/09 12:40
SLRC 030003 July 2009 Removal (TS)	WSG0822-30	07/23/09 12:45
SLRC 030003 July 2009 Removal (Calc)	WSG0822-31	07/23/09 12:45
SLRC 030003 July 2009 Removal (Fine)	WSG0822-32	07/23/09 12:45
SLRC 030003 July 2009 Removal (Coarse)	WSG0822-33	07/23/09 12:45

Samples were received into laboratory at a temperature of 12 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

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ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-01 (SLRC 050007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:45			
General Chemistry Parameters									
% Solids	94		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-02 (SLRC 050007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	190		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-03 (SLRC 050007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	200		mg/kg	1.2	1	07/29/09 11:03	gaf	9070672	SW 6010B
Sample ID: WSG0822-04 (SLRC 050007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:45			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 11:06	gaf	9070672	SW 6010B

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Analyte	Sample Result	Data Qualifiers	Units	MDL	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-05 (SLEB 030003 July 2009 Removal - Water - NonPotable)							Sampled: 07/23/09 12:30			
Metals										
Lead	0.43		ug/L	0.12	0.40	1	07/28/09 12:51	gaf	9070628	SW 6020A

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-06 (SLRC 030006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 13:00			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-07 (SLRC 030006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	94		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-08 (SLRC 030006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	150		mg/kg	1.2	1	07/29/09 11:10	gaf	9070672	SW 6010B
Sample ID: WSG0822-09 (SLRC 030006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 13:00			
Metals									
Lead	36		mg/kg	1.2	1	07/29/09 11:14	gaf	9070672	SW 6010B
Sample ID: WSG0822-10 (SLRC 030001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:35			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-11 (SLRC 030001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	26		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-12 (SLRC 030001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	35		mg/kg	1.2	1	07/29/09 11:17	gaf	9070672	SW 6010B
Sample ID: WSG0822-13 (SLRC 030001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:35			
Metals									
Lead	13		mg/kg	1.2	1	07/29/09 11:21	gaf	9070672	SW 6010B
Sample ID: WSG0822-14 (SLRC 030004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:50			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-15 (SLRC 030004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	110		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-16 (SLRC 030004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 11:25	gaf	9070672	SW 6010B
Sample ID: WSG0822-17 (SLRC 030004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:50			
Metals									
Lead	74		mg/kg	1.2	1	07/29/09 11:29	gaf	9070672	SW 6010B
Sample ID: WSG0822-18 (SLDUP 030003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-19 (SLDUP 030003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	120		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-20 (SLDUP 030003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 11:32	gaf	9070672	SW 6010B
Sample ID: WSG0822-21 (SLDUP 030003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09			
Metals									
Lead	120		mg/kg	1.2	1	07/29/09 11:36	gaf	9070672	SW 6010B
Sample ID: WSG0822-22 (SLRC 030005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:55			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-23 (SLRC 030005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	18		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-24 (SLRC 030005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	24		mg/kg	1.2	1	07/29/09 11:54	gaf	9070672	SW 6010B
Sample ID: WSG0822-25 (SLRC 030005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:55			
Metals									
Lead	13		mg/kg	1.2	1	07/29/09 12:04	gaf	9070672	SW 6010B
Sample ID: WSG0822-26 (SLRC 030002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:40			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-27 (SLRC 030002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	200		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B
Sample ID: WSG0822-28 (SLRC 030002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	250		mg/kg	1.2	1	07/29/09 12:15	gaf	9070672	SW 6010B
Sample ID: WSG0822-29 (SLRC 030002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:40			
Metals									
Lead	68		mg/kg	1.2	1	07/29/09 12:19	gaf	9070672	SW 6010B
Sample ID: WSG0822-30 (SLRC 030003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 12:45			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0822-31 (SLRC 030003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	0.048	0.04	07/30/09 14:26	mmm	9070730	SW 6010B

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0822-32 (SLRC 030003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	1.2	1	07/29/09 13:25	gaf	9070688	SW 6010B
Sample ID: WSG0822-33 (SLRC 030003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 12:45			
Metals									
Lead	12		mg/kg	1.2	1	07/29/09 13:29	gaf	9070688	SW 6010B

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Work Order: WSG0822
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070628			ug/L	0.12	0.40	<0.12							
Lead	9070672			mg/kg	N/A	1.2	<1.2							
Lead	9070688			mg/kg	N/A	1.2	<1.2							

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Work Order: WSG0822
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Received: 07/24/09
Reported: 07/30/09 14:31

LABORATORY DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
General Chemistry Parameters													
QC Source Sample: WSG0822-01													
% Solids	9070700	94.4		%	N/A	N/A	94.4				0	20	
QC Source Sample: WSG0822-18													
% Solids	9070700	98.6		%	N/A	N/A	98.7				0	20	

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Work Order: WSG0822
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 14:31

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070628		50	ug/L	0.12	0.40	55.2		110		80-120			
Lead	9070672		100	mg/kg	N/A	1.2	104		104		80-120			
Lead	9070688		100	mg/kg	N/A	1.2	104		104		80-120			

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Project: USCG Ludington
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Received: 07/24/09
Reported: 07/30/09 14:31

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
QC Source Sample: WSG0831-06														
Lead	9070628	0.180	50	ug/L	0.12	0.40	54.1	54.1	108	108	75-125	0	20	
QC Source Sample: WSG0822-24														
Lead	9070672	24.4	100	mg/kg	N/A	1.2	120	131	96	107	80-120	9	18	
QC Source Sample: WSG0822-25														
Lead	9070672	13.0	100	mg/kg	N/A	1.2	118	124	105	111	80-120	5	18	
QC Source Sample: WSG0826-32														
Lead	9070688	116	100	mg/kg	N/A	1.2	171	314	55	197	80-120	59	18	M8,M7
QC Source Sample: WSG0826-33														
Lead	9070688	33.0	100	mg/kg	N/A	1.2	146	147	113	114	80-120	0	18	

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DATA QUALIFIERS AND DEFINITIONS

M7 The MS and/or MSD were above the acceptance limits. See Blank Spike (LCS).
M8 The MS and/or MSD were below the acceptance limits. See Blank Spike (LCS).

ADDITIONAL COMMENTS

Chain of Custody Record

WSG0822

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TAL-4142 (0408)

Client Arcladis			Project Manager Mark Kittinger			Date 7-23-2009		Chain of Custody Number 017612	
Address 28550 Cabot Dr Suite 500			Telephone Number (Area Code)/Fax Number 248-444-2288			Lab Number NA		Page 1 of 1	
City Novi	State MI	Zip Code 48377	Site Contact T. Sclafani		Lab Contact W. Topel		Analysis (Attach list if more space is needed)		
Project Name and Location (State) US Coast Guard Old Station Ludington			Carrier/Waybill Number 8681 4831 3910			Special Instructions/ Conditions of Receipt			
Contract/Purchase Order/Quote No. A09-0066									

Sample I.D. No. and Description (Containers for each sample may be combined on one line)			Date	Time	Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc	NaOH	Lead	Total																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
-01-04	SLRC050007-July 2009 Removal		7-23-09	1145				1	1							1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

Possible Hazard Identification					Sample Disposal					QC Requirements (Specify)				
<input checked="" type="checkbox"/> Non-Hazard	<input type="checkbox"/> Flammable	<input type="checkbox"/> Skin Irritant	<input type="checkbox"/> Poison B	<input type="checkbox"/> Unknown	<input type="checkbox"/> Return To Client	<input checked="" type="checkbox"/> Disposal By Lab	<input type="checkbox"/> Archive For	Months		(A fee may be assessed if samples are retained longer than 1 month)				

Turn Around Time Required					QC Requirements (Specify)									
<input type="checkbox"/> 24 Hours	<input type="checkbox"/> 48 Hours	<input type="checkbox"/> 7 Days	<input type="checkbox"/> 14 Days	<input type="checkbox"/> 21 Days	<input checked="" type="checkbox"/> Other	5 Day				Level III				
1. Relinquished By					Date					Time				
2. Relinquished By					Date					Time				
3. Relinquished By					Date					Time				

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

7/24/09

July 30, 2009

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WSG0826
Project Name: USCG Ludington
Project Number: D09-0066

Attn: Mr. Troy Sclafani

Date Received: 07/24/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLEB 020002 July 2009 Removal	WSG0826-01	07/22/09 17:15
SLRC 040001 July 2009 Removal (TS)	WSG0826-02	07/22/09 15:55
SLRC 040001 July 2009 Removal (Calc)	WSG0826-03	07/22/09 15:55
SLRC 040001 July 2009 Removal (Fine)	WSG0826-04	07/22/09 15:55
SLRC 040001 July 2009 Removal (Coarse)	WSG0826-05	07/22/09 15:55
SLRC 040002 July 2009 Removal (TS)	WSG0826-06	07/22/09 16:05
SLRC 040002 July 2009 Removal (Calc)	WSG0826-07	07/22/09 16:05
SLRC 040002 July 2009 Removal (Fine)	WSG0826-08	07/22/09 16:05
SLRC 040002 July 2009 Removal (Coarse)	WSG0826-09	07/22/09 16:05
SLRC 040004 July 2009 Removal (TS)	WSG0826-10	07/22/09 16:20
SLRC 040004 July 2009 Removal (Calc)	WSG0826-11	07/22/09 16:20
SLRC 040004 July 2009 Removal (Fine)	WSG0826-12	07/22/09 16:20
SLRC 040004 July 2009 Removal (Coarse)	WSG0826-13	07/22/09 16:20
SLRC 040005 July 2009 Removal (TS)	WSG0826-14	07/22/09 16:30
SLRC 040005 July 2009 Removal (Calc)	WSG0826-15	07/22/09 16:30
SLRC 040005 July 2009 Removal (Fine)	WSG0826-16	07/22/09 16:30
SLRC 040005 July 2009 Removal (Coarse)	WSG0826-17	07/22/09 16:30
SLRC 040006 July 2009 Removal (TS)	WSG0826-18	07/22/09 16:35
SLRC 040006 July 2009 Removal (Calc)	WSG0826-19	07/22/09 16:35
SLRC 040006 July 2009 Removal (Fine)	WSG0826-20	07/22/09 16:35
SLRC 040006 July 2009 Removal (Coarse)	WSG0826-21	07/22/09 16:35
SLRC 040007 July 2009 Removal (TS)	WSG0826-22	07/22/09 16:37
SLRC 040007 July 2009 Removal (Calc)	WSG0826-23	07/22/09 16:37
SLRC 040007 July 2009 Removal (Fine)	WSG0826-24	07/22/09 16:37
SLRC 040007 July 2009 Removal (Coarse)	WSG0826-25	07/22/09 16:37
SLDUP 040002 July 2009 Removal (TS)	WSG0826-26	07/22/09

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Work Order: WSG0826
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:41

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLDUP 040002 July 2009 Removal (Calc)	WSG0826-27	07/22/09
SLDUP 040002 July 2009 Removal (Fine)	WSG0826-28	07/22/09
SLDUP 040002 July 2009 Removal (Coarse)	WSG0826-29	07/22/09
SLRC 040008 July 2009 Removal (TS)	WSG0826-30	07/22/09 16:45
SLRC 040008 July 2009 Removal (Calc)	WSG0826-31	07/22/09 16:45
SLRC 040008 July 2009 Removal (Fine)	WSG0826-32	07/22/09 16:45
SLRC 040008 July 2009 Removal (Coarse)	WSG0826-33	07/22/09 16:45

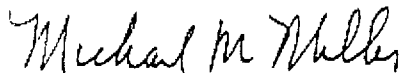
Samples were received on ice into laboratory at a temperature of 6 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
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Mr. Troy Sclafani

Work Order: WSG0826
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:41

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-01 (SLEB 020002 July 2009 Removal - Water - NonPotable)						Sampled: 07/22/09 17:15			
Metals									
Lead	0.14	J	ug/L	0.12	0.40	07/28/09 12:51	gaf	9070628	SW 6020A

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Reported: 07/30/09 15:41

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-02 (SLRC 040001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 15:55			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-03 (SLRC 040001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	150		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-04 (SLRC 040001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	260		mg/kg	1.2	1	07/29/09 13:32	gaf	9070688	SW 6010B
Sample ID: WSG0826-05 (SLRC 040001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 15:55			
Metals									
Lead	75		mg/kg	1.2	1	07/29/09 13:36	gaf	9070688	SW 6010B
Sample ID: WSG0826-06 (SLRC 040002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:05			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-07 (SLRC 040002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	66		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-08 (SLRC 040002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	100		mg/kg	1.2	1	07/29/09 13:40	gaf	9070688	SW 6010B
Sample ID: WSG0826-09 (SLRC 040002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:05			
Metals									
Lead	43		mg/kg	1.2	1	07/29/09 13:44	gaf	9070688	SW 6010B
Sample ID: WSG0826-10 (SLRC 040004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:20			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035
Sample ID: WSG0826-11 (SLRC 040004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	260		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-12 (SLRC 040004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	330		mg/kg	1.2	1	07/29/09 13:47	gaf	9070688	SW 6010B
Sample ID: WSG0826-13 (SLRC 040004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:20			
Metals									
Lead	210		mg/kg	1.2	1	07/29/09 13:51	gaf	9070688	SW 6010B
Sample ID: WSG0826-14 (SLRC 040005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:30			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:26	LER	9070700	SW 5035

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-15 (SLRC 040005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	81		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-16 (SLRC 040005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	160		mg/kg	1.2	1	07/29/09 14:06	gaf	9070688	SW 6010B
Sample ID: WSG0826-17 (SLRC 040005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:30			
Metals									
Lead	46		mg/kg	1.2	1	07/29/09 14:09	gaf	9070688	SW 6010B
Sample ID: WSG0826-18 (SLRC 040006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:35			
General Chemistry Parameters									
% Solids	99		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-19 (SLRC 040006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	210		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-20 (SLRC 040006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	370		mg/kg	1.2	1	07/29/09 14:13	gaf	9070688	SW 6010B
Sample ID: WSG0826-21 (SLRC 040006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:35			
Metals									
Lead	120		mg/kg	1.2	1	07/29/09 14:16	gaf	9070688	SW 6010B
Sample ID: WSG0826-22 (SLRC 040007 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:37			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-23 (SLRC 040007 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	56		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-24 (SLRC 040007 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	78		mg/kg	1.2	1	07/29/09 14:20	gaf	9070688	SW 6010B
Sample ID: WSG0826-25 (SLRC 040007 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:37			
Metals									
Lead	42		mg/kg	1.2	1	07/29/09 14:24	gaf	9070688	SW 6010B
Sample ID: WSG0826-26 (SLDUP 040002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-27 (SLDUP 040002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	53		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0826-28 (SLDUP 040002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	110		mg/kg	1.2	1	07/29/09 14:27	gaf	9070688	SW 6010B
Sample ID: WSG0826-29 (SLDUP 040002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09			
Metals									
Lead	22		mg/kg	1.2	1	07/29/09 14:31	gaf	9070688	SW 6010B
Sample ID: WSG0826-30 (SLRC 040008 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/22/09 16:45			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0826-31 (SLRC 040008 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	93		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0826-32 (SLRC 040008 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	120		mg/kg	1.2	1	07/29/09 14:34	gaf	9070688	SW 6010B
Sample ID: WSG0826-33 (SLRC 040008 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/22/09 16:45			
Metals									
Lead	33		mg/kg	1.2	1	07/29/09 14:56	gaf	9070688	SW 6010B

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Received: 07/24/09
Reported: 07/30/09 15:41

LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
Lead	9070628			ug/L	0.12	0.40	<0.12							
Lead	9070688			mg/kg	N/A	1.2	<1.2							

ARCADIS - MICHIGAN
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Received: 07/24/09
Reported: 07/30/09 15:41

LABORATORY DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
General Chemistry Parameters													
QC Source Sample: WSG0822-01													
% Solids	9070700	94.4		%	N/A	N/A	94.4				0	20	
QC Source Sample: WSG0822-18													
% Solids	9070700	98.6		%	N/A	N/A	98.7				0	20	
QC Source Sample: WSG0826-18													
% Solids	9070701	99.5		%	N/A	N/A	99.4				0	20	
QC Source Sample: WSG0827-17													
% Solids	9070701	95.5		%	N/A	N/A	95.5				0	20	

ARCADIS - MICHIGAN
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Received: 07/24/09
Reported: 07/30/09 15:41

LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070628		50	ug/L	0.12	0.40	55.2		110		80-120			
Lcad	9070688		100	mg/kg	N/A	1.2	104		104		80-120			

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Reported: 07/30/09 15:41

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
Metals														
QC Source Sample: WSG0831-06														
Lead	9070628	0.180	50	ug/L	0.12	0.40	54.1	54.1	108	108	75-125	0	20	
QC Source Sample: WSG0826-32														
Lead	9070688	116	100	mg/kg	N/A	1.2	171	314	55	197	80-120	59	18	MS,M7
QC Source Sample: WSG0826-33														
Lead	9070688	33.0	100	mg/kg	N/A	1.2	146	147	113	114	80-120	0	18	

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Mr. Troy Sclafani

Work Order: WSG0826
Project: USCG Ludington
Project Number: D09-0066

Received: 07/24/09
Reported: 07/30/09 15:41

DATA QUALIFIERS AND DEFINITIONS

J Results reported between the Method Detection Limit (MDL) and Limit of Quantitation (LOQ) are less certain than results at or above the LOQ.

M7 The MS and/or MSD were above the acceptance limits. See Blank Spike (LCS).

M8 The MS and/or MSD were below the acceptance limits. See Blank Spike (LCS).

ADDITIONAL COMMENTS

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

July 30, 2009

Client: ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377

Work Order: WSG0827
Project Name: USCG Ludington
Project Number: D09-0066

Attn: Mr. Troy Sclafani

Date Received: 07/24/09

An executed copy of the chain of custody is also included as an addendum to this report.

If you have any questions relating to this analytical report, please contact your Laboratory Project Manager at 1-800-833-7036

SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 040010 July 2009 Removal (TS)	WSG0827-01	07/23/09 09:39
SLRC 040010 July 2009 Removal (Calc)	WSG0827-02	07/23/09 09:39
SLRC 040010 July 2009 Removal (Fine)	WSG0827-03	07/23/09 09:39
SLRC 040010 July 2009 Removal (Coarse)	WSG0827-04	07/23/09 09:39
SLRC 040011 July 2009 Removal (TS)	WSG0827-05	07/23/09 09:48
SLRC 040011 July 2009 Removal (Calc)	WSG0827-06	07/23/09 09:48
SLRC 040011 July 2009 Removal (Fine)	WSG0827-07	07/23/09 09:48
SLRC 040011 July 2009 Removal (Coarse)	WSG0827-08	07/23/09 09:48
SLRC 050001 July 2009 Removal (TS)	WSG0827-09	07/23/09 10:55
SLRC 050001 July 2009 Removal (Calc)	WSG0827-10	07/23/09 10:55
SLRC 050001 July 2009 Removal (Fine)	WSG0827-11	07/23/09 10:55
SLRC 050001 July 2009 Removal (Coarse)	WSG0827-12	07/23/09 10:55
SLRC 050002 July 2009 Removal (TS)	WSG0827-13	07/23/09 11:00
SLRC 050002 July 2009 Removal (Calc)	WSG0827-14	07/23/09 11:00
SLRC 050002 July 2009 Removal (Fine)	WSG0827-15	07/23/09 11:00
SLRC 050002 July 2009 Removal (Coarse)	WSG0827-16	07/23/09 11:00
SLRC 050003 July 2009 Removal (TS)	WSG0827-17	07/23/09 11:10
SLRC 050003 July 2009 Removal (Calc)	WSG0827-18	07/23/09 11:10
SLRC 050003 July 2009 Removal (Fine)	WSG0827-19	07/23/09 11:10
SLRC 050003 July 2009 Removal (Coarse)	WSG0827-20	07/23/09 11:10
SLRC 050004 July 2009 Removal (TS)	WSG0827-21	07/23/09 11:20
SLRC 050004 July 2009 Removal (Calc)	WSG0827-22	07/23/09 11:20
SLRC 050004 July 2009 Removal (Fine)	WSG0827-23	07/23/09 11:20
SLRC 050004 July 2009 Removal (Coarse)	WSG0827-24	07/23/09 11:20
SLRC 050005 July 2009 Removal (TS)	WSG0827-25	07/23/09 11:30
SLRC 050005 July 2009 Removal (Calc)	WSG0827-26	07/23/09 11:30

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SAMPLE IDENTIFICATION	LAB NUMBER	COLLECTION DATE AND TIME
SLRC 050005 July 2009 Removal (Fine)	WSG0827-27	07/23/09 11:30
SLRC 050005 July 2009 Removal (Coarse)	WSG0827-28	07/23/09 11:30
SLRC 050006 July 2009 Removal (TS)	WSG0827-29	07/23/09 11:35
SLRC 050006 July 2009 Removal (Calc)	WSG0827-30	07/23/09 11:35
SLRC 050006 July 2009 Removal (Fine)	WSG0827-31	07/23/09 11:35
SLRC 050006 July 2009 Removal (Coarse)	WSG0827-32	07/23/09 11:35

Samples were received into laboratory at a temperature of 10 °C.

The reported results were obtained in compliance with the 2003 NELAC standards unless otherwise noted.

The Chain of Custody, 1 page, is included and is an integral part of this report.

Unless subcontracted, volatiles analyses (including VOC, PVOC, GRO, BTEX, and TPH gasoline) performed by TestAmerica Watertown at 1101 Industrial Drive, Units 9&10. All other analyses performed at the address shown in the heading of this report.

Approved By:



TestAmerica Watertown
Mike Miller For Warren L. Topel
Project Manager

ARCADIS - MICHIGAN
28550 Cabot Drive; Suite 500
Novi, MI 48377
Mr. Troy Sclafani

Work Order: WSG0827
Project: USCG Ludington
Project Number: D09-0066

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Reported: 07/30/09 15:52

ANALYTICAL REPORT

Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-01 (SLRC 040010 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 09:39			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-02 (SLRC 040010 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	47		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-03 (SLRC 040010 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	65		mg/kg	1.2	1	07/29/09 15:28	gaf	9070689	SW 6010B
Sample ID: WSG0827-04 (SLRC 040010 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 09:39			
Metals									
Lead	38		mg/kg	1.2	1	07/29/09 15:43	gaf	9070689	SW 6010B
Sample ID: WSG0827-05 (SLRC 040011 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 09:48			
General Chemistry Parameters									
% Solids	98		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-06 (SLRC 040011 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	61		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-07 (SLRC 040011 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	85		mg/kg	1.2	1	07/29/09 15:47	gaf	9070689	SW 6010B
Sample ID: WSG0827-08 (SLRC 040011 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 09:48			
Metals									
Lead	24		mg/kg	1.2	1	07/29/09 15:50	gaf	9070689	SW 6010B
Sample ID: WSG0827-09 (SLRC 050001 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 10:55			
General Chemistry Parameters									
% Solids	94		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-10 (SLRC 050001 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	200		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-11 (SLRC 050001 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 15:54	gaf	9070689	SW 6010B
Sample ID: WSG0827-12 (SLRC 050001 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 10:55			
Metals									
Lead	220		mg/kg	1.2	1	07/29/09 15:58	gaf	9070689	SW 6010B
Sample ID: WSG0827-13 (SLRC 050002 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:00			
General Chemistry Parameters									
% Solids	93		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-14 (SLRC 050002 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	180		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-15 (SLRC 050002 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	170		mg/kg	1.2	1	07/29/09 16:02	gaf	9070689	SW 6010B
Sample ID: WSG0827-16 (SLRC 050002 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:00			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 16:05	gaf	9070689	SW 6010B
Sample ID: WSG0827-17 (SLRC 050003 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:10			
General Chemistry Parameters									
% Solids	96		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-18 (SLRC 050003 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	29		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-19 (SLRC 050003 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	23		mg/kg	1.2	1	07/29/09 16:09	gaf	9070689	SW 6010B
Sample ID: WSG0827-20 (SLRC 050003 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:10			
Metals									
Lead	31		mg/kg	1.2	1	07/29/09 16:12	gaf	9070689	SW 6010B
Sample ID: WSG0827-21 (SLRC 050004 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:20			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-22 (SLRC 050004 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	82		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-23 (SLRC 050004 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	100		mg/kg	1.2	1	07/29/09 16:16	gaf	9070689	SW 6010B
Sample ID: WSG0827-24 (SLRC 050004 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:20			
Metals									
Lead	72		mg/kg	1.2	1	07/29/09 16:31	gaf	9070689	SW 6010B
Sample ID: WSG0827-25 (SLRC 050005 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:30			
General Chemistry Parameters									
% Solids	95		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-26 (SLRC 050005 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	120		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B

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Analyte	Sample Result	Data Qualifiers	Units	MRL	Dilution Factor	Date Analyzed	Analyst	Seq/ Batch	Method
Sample ID: WSG0827-27 (SLRC 050005 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	97		mg/kg	1.2	1	07/29/09 16:34	gaf	9070689	SW 6010B
Sample ID: WSG0827-28 (SLRC 050005 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:30			
Metals									
Lead	130		mg/kg	1.2	1	07/29/09 16:38	gaf	9070689	SW 6010B
Sample ID: WSG0827-29 (SLRC 050006 July 2009 Removal (TS) - Solid/Soil)						Sampled: 07/23/09 11:35			
General Chemistry Parameters									
% Solids	93		%	NA	1	07/29/09 10:28	LER	9070701	SW 5035
Sample ID: WSG0827-30 (SLRC 050006 July 2009 Removal (Calc) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	230		mg/kg	0.048	0.04	07/30/09 15:38	mmm	9070730	SW 6010B
Sample ID: WSG0827-31 (SLRC 050006 July 2009 Removal (Fine) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	180		mg/kg	1.2	1	07/29/09 16:41	gaf	9070689	SW 6010B
Sample ID: WSG0827-32 (SLRC 050006 July 2009 Removal (Coarse) - Solid/Soil)						Sampled: 07/23/09 11:35			
Metals									
Lead	250		mg/kg	1.2	1	07/29/09 16:52	gaf	9070689	SW 6010B

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LABORATORY BLANK QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070689			mg/kg	N/A	1.2	<1.2							

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LABORATORY DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	% REC	Dup %REC	% REC Limits	RPD RPD	RPD Limit	Q
General Chemistry Parameters													
QC Source Sample: WSG0826-18													
% Solids	9070701	99.5		%	N/A	N/A	99.4				0	20	
QC Source Sample: WSG0827-17													
% Solids	9070701	95.5		%	N/A	N/A	95.5				0	20	

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LCS/LCS DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
Lead	9070689		100	mg/kg	N/A	1.2	109		109		80-120			

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Mr. Troy Sclafani

Work Order: WSG0827
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Received: 07/24/09
Reported: 07/30/09 15:52

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC DATA

Analyte	Seq/ Batch	Source Result	Spike Level	Units	MDL	MRL	Result	Dup Result	% REC	Dup %REC	% REC Limits	RPD RPD	Limit	Q
Metals														
QC Source Sample: WSG0827-31														
Lead	9070689	179	100	mg/kg	N/A	1.2	310	328	131	149	80-120	6	18	M7
QC Source Sample: WSG0827-32														
Lead	9070689	252	100	mg/kg	N/A	1.2	369	382	117	130	80-120	3	18	M7

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DATA QUALIFIERS AND DEFINITIONS

M7 The MS and/or MSD were above the acceptance limits. See Blank Spike (LCS).

ADDITIONAL COMMENTS

WSG 0827

THE LEADER IN ENVIRONMENTAL TESTING

Client Arcadis		Project Manager Mark Kittinger		Date 7-23-09	Chain of Custody Number 017609	
Address 28550 Cabot Dr Suite 500		Telephone Number (Area Code)/Fax Number 248-994-2288		Lab Number HC WT		Page 1 of 1
City Novi	State MI	Zip Code 48377	Site Contact J. Sclafani	Lab Contact W. Tomei	Analysis (Attach list if more space is needed)	
Project Name and Location (State) US Coast Guard 118 Station Ludington			Carrier/Waybill Number 8689 3938 7850			
Contract/Purchase Order/Quote No. 109-0066			Matrix	Containers & Preservatives	Special Instructions/ Conditions of Receipt	

[illegible]

Possible Hazard Identification		Sample Disposal		(A fee may be assessed if samples are retained longer than 1 month)	
<input checked="" type="checkbox"/> Non-Hazard	<input type="checkbox"/> Flammable	<input type="checkbox"/> Skin Irritant	<input type="checkbox"/> Poison B	<input type="checkbox"/> Unknown	<input type="checkbox"/> Return To Client
<input type="checkbox"/> Disposal By Lab	<input type="checkbox"/> Archive For _____ Months				
Turn Around Time Required		QC Requirements (Specify)			
<input type="checkbox"/> 24 Hours	<input type="checkbox"/> 48 Hours	<input type="checkbox"/> 7 Days	<input type="checkbox"/> 14 Days	<input type="checkbox"/> 21 Days	<input checked="" type="checkbox"/> Other <u>5 Day</u>
1. Relinquished By <u>Tyler</u>		Date <u>7/23/09</u>	Time <u>1520</u>	1. Received By <u>M. Pinto</u>	
2. Relinquished By <u>(Signature)</u>		Date	Time	2. Received By	
3. Relinquished By		Date	Time	3. Received By	

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

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